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THE PHASE II REPORT OF THE AUDIT OF THE ACIDIC PRECIPITATION IN ONTARIO STUDY DEPOSITION MONITORING NETWORK

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DISCLAIMER

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1. SUMMARY

Concord Scientific Corporation (CSC) has been contracted by the Ontario Ministry of the Environment (MOE) to carry out two audits of the Acidic Precipitation in Ontario Study (APIOS) monitoring network (laboratory activities were not included in the audit since these aspects were extensively addressed in a previous audit, (CSC, 1982)).

This quality assurance audit provides an independent review and evaluation of the operating and quality assurance procedures for the APIOS monitoring network. As defined in Phase I, the objective of the audit is to assess how the various components within the APIOS programme are contributing to the production of "high quality" data.

In general, the Phase II audits indicate that the APIOS personnel are properly executing the procedures that are documented in the APIOS Technical and Operating Manual (Bardswick, 1983).

Operators' training for the most part has been upgraded or reinforced and operators are following the currently recommended operating and handling procedures. This ensures that good quality data are collected.

The majority of the monitoring sites visited during this audit met siting criteria and the instruments were operating according to

design specifications. Sites which are in violation of the siting criteria, or operators not using approved handling procedures and therefore jeopardizing sample integrity, are described in detail in the performance related findings of the audit report (Section 3.1). A special review by the QA Coordinator (QAC) of these specific sites and operators should be carried out.

Since the Phase I audit, the data validation procedures for cumulative and daily air concentration data have been documented (Chung, 1984; Kirk, 1984) and the 1982 daily and cumulative air concentration listings have been published (MOE, 1984). These data validation procedures have been well conceived in general, however, some recommendations with reference to data qualification and reporting have been made (Section 4.1).

As recommended by the QAC, the data handling portion of the audit consisted of a performance audit of cumulative and daily air concentration data and a systems audit of sequential sampler methodologies and data handling procedures.

A draft copy of the APIOS QA Manual (CSC, 1984b) has been submitted to the APIOS management for review. As described in the Phase I audit (CSC, 1984a), this manual brings together all the various quality assurance procedures currently being carried out (e.g. co-located sam-

pling, calibration, blind samples, etc.) as well as describing QA activities which have not yet been incorporated into the operating system (e.g. internal audits, corrective action, procurement control, etc.). This manual also decribes how these procedures fit together in the quality assurance system, so that estimates of data accuracy, precision, completeness, comparability and representativeness can be made.

Finally, as stated in the Phase I audit, the auditors have noticed marked improvements in all areas of the programme, particularly in the areas of network documentation, data validation and the implementation of additional routine QC procedures. With the completion of the QA manual, the full APIOS quality assurance programme can become operational, and network data evaluated with respect to the network QA objectives and the standard QA elements of accuracy, precision, representativeness and comparability.

2. INTRODUCTION

Concord Scientific Corporation (CSC) has undertaken on behalf of the Ontario Ministry of the Environment (MOE) two audits of its Acidic Precipitation in Ontario Study (APIOS) monitoring network (laboratory activities were not included in the audit since these aspects were extensively addressed in a previous audit, (CSC, 1982)).

The Phase I audit was carried out during the fall of 1983 through to the winter of 1984 and the Phase II audit was carried out during the summer of 1984. The findings of the Phase I audit were presented in the Phase I Report (CSC, 1984a) to the APIOS QA Coordinator.

This report contains the findings of the Phase II audit including recommendations for changes to the APIOS programme. Volume I of this report contains four main chapters as did the Phase I Report.

The first chapter summarizes the audit results and points out major strengths and weaknesses of the programme. The third chapter is dedicated to performance related audit findings. These findings are a quantitative and qualitative measure of how well the APIOS procedures are being executed. The fourth chapter reports on system related audit findings, and gives details on modifications recommended to aspects of the programme which will assist in attainment of both network and quality assurance objectives (Bardswick, 1983b) and provide greater

efficiency in operations. The last chapter collates the recommendations described throughout the report in a summary form, as well as reviews the actions on the recommendations from the Phase I audit.

Volume II of the Phase II Audit Report contains the completed Phase II site audit questionnaires prepared by CSC's auditors, including photographs of the audited sites.

3. PERFORMANCE RELATED AUDIT

The purpose of a performance audit is to quantitatively evaluate the quality of the data produced by the total measurement system, e.g. sample collection, sample analysis and data processing (U.S. EPA 1977).

The performance audit carried out in Phase II is broken down into three components, site audits, technologist audits, and data handling and validation audits. For each of the components the network's performance with respect to documented APIOS procedures was described in quantitative and qualitative terms. The findings are discussed below and the recommendations from this chapter are summarized in Chapter 5.

3.1 Status of Monitoring Sites

Site evaluations were carried out at thirteen APIOS monitoring stations. The list of sites inspected is presented in Table 3.1.

The site visits included audits and evaluations of the site, operator sample handling procedures, plus configuration and calibration checks on instrumentation.

The questionnaires and audit check lists used during the site visits are identical to those used during the Phase I Audit, and are

TABLE 3.1

Sites Visited During the Phase II Site Audits

Site	Type
Merlin	Cumulative Wet
Port Stanley	Cumulative Wet & Dry
Pickle Lake	Cumulative Wet & Dry
Forbes Township	Event Wet
Quetico Centre	Cumulative Wet and Event Wet
Ear Falls	Cumulative Wet & Dry
Experimental Lakes Area	Cumulative Wet
Dorset	Cumulative Wet & Dry, Event Wet & Dry
Whitney	Cumulative Wet
Coldwater	Cumulative Wet
Gowganda	Cumulative Wet & Dry
Winisk	Cumulative Wet
Whitman Creek	Event Wet

presented in Appendix I. The completed questionnaires, site and aerial photographs are presented under a separate cover in Volume II of this report. Site audit summaries are presented in Appendix II. These summaries include site evaluations, instrument evaluations, operator evaluations and corrective action required at each site.

Table 3.2 summarizes the audit findings for each site. This table is broken down into two components, a physical siting related component and an operations related component. The guidelines utilized for the completion of this table are presented in Table 3.3. Each component was assigned a rating, and in order for these ratings to be comparable with the subjective evaluation performed by regional technologists, the auditors used the APIOS Ranking Criteria (Table 3.4) as a guideline. A summary of the siting and operations ratings for all sites audited is presented in Table 3.5.

As was described in Phase I, a marginal or poor rating requires that the QA Coordinator review the site and make appropriate changes to improve the rating or relocate the site. A marginal rating is an alert that potential problems exist and a poor rating indicates that changes should be made immediately.

Sites that have been classified as poor are discussed in more detail below, and where applicable, site changes are recommended. The importance of the deviations from the siting criteria should be

TABLE 3.2

Summary - Phase II Site Audit Findings

	Ear Falls	E.L.A.	Quetico Centre
I SITING			
a) Windbreak	180° (mixed)	90° (burned Coniferous)	330° (mixed)
b) Ground Cover	Poor (clay & exposed earth)	Good (bedrock, moss)	Good
c) Obstructions	Yes (trees, gasoline storage tank)	Met Tower H=10m 14m E	None
d) Rep. of Topography	Yes	Yes	Yes
e) Roads/Transportation	Access road & parking lot (gravel)	None	Access rd. 30m W (paved)
f) Agriculture	None	None	None
g) Towns/Cities	Ear Falls (<1 km)	None	None
h) Pollution Sources	Open pit iron ore mine 25km N	None	None
i) Power Failures	3 per year	1-2 per year	1-2 per year
j) Deviations	Poor ground cover, obstructions, proximity to road, construction, open pit mine	Tower - influence is minimal	Proximity to road
k) Advantages	Site is accessible and secure	Remote and representative	Remote and representative
l) Rating	Poor - many deviations	Excellent	Excellent
II OPERATIONS			
a) Condition of Instr. - Present	Chain needs tightening, limit switch needs to be replaced & adjusted	Motor humming otherwise good	Good
- Past		Good	Good
b) Understanding - Has manual	N/A	Sections pertaining to him	Yes
- Read manual		Yes	Yes
- Understands Protocol	OPERATOR	Yes	Yes
c) Follows Protocol - Instr. Checks	WAS NOT	Daily	Instrument checked daily - well maintained.
- Sample Handling	PRESENT	Good - follows protocol	Operator needs to be retrained in sample handling - possible source of contamination, std. gauge taken properly
- Cleaning	FOR	Good	
- Storage (sample)	THE	Follows protocol	
- Std. Gauge Protocol	AUDIT		
d) Attitude		Good	Good attitude - but feels too much paper work
e) Reaction to Problems		Good	Good, telephones technologist
f) Submission Forms		Properly filled out	Properly filled out
g) Retraining Needed		None	Yes - needs to be retrained on sample handling
h) Deviations		None	Leans over pail, same gloves used to pat down bag as to install
i) Advantage		Conscientious Interested in network would like more info on APIOS and complete operations manual	- checks sampler daily - conscientious
j) Rating		Excellent	Good (retraining)

TABLE 3.2 (cont'd)

Summary - Phase II Site Audit Findings

	Dorset	Whitney	Coldwater
I SITING			
a) Windbreak	360° (mixed)	360° (mixed)	360° (deciduous)
b) Ground Cover	Compound - good; surrounding fair	Marginal (some exposed earth weeds need cutting)	Good, cut grass
c) Obstructions	None	None	None
d) Rep. of Topography	Yes	Yes	Yes
e) Roads/Transportation	Driveway - dirt 50m ENE	None	None
f) Agriculture	None	None	Yes-corn/hay (500m-1km ENE)
g) Towns/Cities	None	None	Orillia 11km pop. 25,000
h) Pollution Sources	None	Sawmill 35km SE (downwind) Marsh 35m NE	Open pit limestone quarry 10-15km NE
i) Power Failures	2 per year	2-3 per year	None
j) Deviations	Proximity to driveway (dirt) Trailers between parking lot and site to reduce influence of windblown contamination Parking lot should be paved	Exposed earth, proximity to marsh (35m) and sawmill	Proximity to limestone quarry and plowed fields
k) Advantages	Meets all siting criteria	Remote, representative, accessibility of power and operator	Meets most siting criteria
l) Rating	Excellent	Marginal, (good if ground cover improved)	Good (*evaluate influence of limestone quarry)
II OPERATIONS			
a) Condition of Instr. - Present	Primary good; secondary need maintenance	Good; clutch needs adjustment	Good
- Past			Good
b) Understanding - Has manual - Read manual - Understands Protocol	Yes Yes Yes	N/A OPERATOR	Yes Yes Yes
c) Follows Protocol - Instr. checks - Sample handling	Yes Does not change gloves to pat down bag	WAS NOT PRESENT FOR THE AUDIT	2x per week Does not follow protocol
- Cleaning - Storage (sample) - Std. Gauge Protocol	Yes Follows protocol		Yes - no gloves Porch Good
d) Attitude	Very good		Excellent
e) Reaction to Problems			Good
f) Submission Forms	Filled out correctly		Filled out correctly
g) Retraining Needed	No - just needs refresher		Yes
h) Deviations	Pats down bag without changing gloves		Folds bag in before it is tied
i) Advantages	APIOS Regional Tech. - follows almost all protocol; good attitude		Does not label bag; does not always use new gloves
j) Rating	Good		Marginal (needs retraining)

(Continued)

TABLE 3.2 (cont'd)

Summary - Phase II Site Audit Findings

	Whitman Creek	Port Stanley	Merlin
I SITING			
a) Windbreak	270° (deciduous)	180° (deciduous) none in prevailing wind direction	180° (scattered houses, barns) poor
b) Ground Cover	Good (grass needs to be cut)	Good	Good
c) Obstructions	None	None	None
d) Rep. of Topography	Yes	Yes	Yes
e) Roads/Transportation	Yes, County Rd. #14 25m S	Access rd. (20m W gravel very light)	County rd. 50m S; gravel access rd. 15 m E
f) Agriculture	None	Yes (but representative 300m)	Yes (but representative 500m, 1km)
g) Towns/Cities	None	None	Merlin <1 km Chatham 15km N (40,000)
h) Pollution Sources	Sawmill 10km E	Treatment plant, oil heated	None
i) Power Failures	Many - battery operated (solar cell source)	3 per month	None, back up generator
j) Deviations	Proximity to road and sawmill unreliable power source	Cultured fields within 1 km Proximity to roads	Proximity to vehicular, agricultural and human activity
k) Advantages	Representative, accessibility, good ground cover, no obstructions	Representative, no obstructions good ground cover	Representative, good ground cover, no obstruction or pollution sources
l) Rating	Marginal (electrical power)	Good	Good
II OPERATIONS			
a) Condition of Instr. - Present - Past	Good sensor sensitivity needs adjustment Poor unreliable during winter months	Good sensor sensitivity needs adjustment Good - but some problems with circuit breaker tripping	Good sensor sensitivity needs adjustment Good
b) Understanding - Has manual - Read manual - Understands Protocol	 Yes Yes Yes	 Yes Yes Yes	 Yes Yes Yes
c) Follows Protocol - Instr. Checks - Sample Handling - Cleaning - Storage (sample) - Std. Gauge Protocol	 Yes Follows protocol Refrigerator Follows protocol	 Daily Uses only 1 pr.of gloves Cleans hood gasket Cabinet in laboratory Follows protocol	 1 per week Follows protocol Yes Box in pump house Follows protocol
d) Attitude	Excellent	Excellent	Excellent
e) Reaction to Problems	Good - informs tech. of any problems	Good - informs tech. of any problems	Good
f) Submission Forms	Completed thoroughly	Completed thoroughly	Completed thoroughly
g) Retraining Needed	No	Yes	No
h) Deviations	None	Does not wear new gloves to touch inside of bag	None
i) Advantages	Conscientious, good attitude	Good attitude	Good attitude follows all protocol
j) Rating	Excellent	Good	Excellent

TABLE 3.2 (cont'd)

Summary - Phase II Site Audit Findings

	Forbes Twp	Pickle Lake	Winisk
I SITING			
a) Windbreak	360° (mixed)	300° (Coniferous)	270° (Coniferous)
b) Ground Cover	Good	Good	Good
c) Obstructions	None	Trees (E, SE) Tower (NE)	None
d) Rep. of Topography	Yes	Yes	Yes
e) Roads/Transportation	None	Hwy. 646, 46m E (very light)	Snowmobile road 1m, Airport Hanger (400m)
f) Agriculture	None	None	None
g) Towns/Cities	None	Pickle Lake (<1 km)	None
h) Pollution Sources	Power plant (35 km) (downwind)	Wood burning source of heat	Diesel generator (24 hrs/day)
i) Power Failures	3 per year	None	None (back-up generator)
j) Deviations	Proximity to power plant	Obstructions, wood burning source of heat	Proximity to snowmobile trail, airport hanger & runway, diesel generator
k) Advantages	Remote, representative	Remote, representative	Remote, representaive
l) Rating	Good	Good - trees should be removed	Marginal
II OPERATIONS			
a) Condition of Instr. - Present	Good	Clutch too tight >35 lbs sensor grid blackened	Not operating at time of audit
- Past	No problems		No maintenance performed
b) Understanding			
- Has manual	Yes (event section)	Yes (cumulative section)	Yes
- Read manual	Yes	Yes	No
- Understands Protocol	Yes	Yes	No
c) Follows Protocol			
- Instr. Checks	Yes	Yes - daily	None
- Sample Handling	Follows protocol	Follows protocol	Does not follow protocol
- Cleaning	Weekly	Cleans gasket but no gloves	None
- Storage (sample)	Refrigerator	Refrig. until shipped	Kept in repair shop
- Std Gauge Protocol	Follows protocol	Follows protocol	Std. gauge empty at time of audit
d) Attitude	Excellent	Poor - temporary oper.	Very poor
e) Reaction to Problems	Good - frequent contact with technician	Good	Does not call when instruments down
f) Submission Forms	Completed thoroughly	Completed thoroughly	Not filled out properly
g) Retraining Needed	No	No	Yes
h) Deviations	None	None	Numerous - too many to list
i) Advantages	Conscientious & follows protocol	Follows protocol	None
j) Rating	Excellent	Good	Poor

TABLE 3.2 (cont'd)

Summary - Phase II Site Audit Findings

	Gowganda		
I SITING			
a) Windbreak	165° (mixed)		
b) Ground Cover	Good (weeds to be cut)		
c) Obstructions	Tower (H-12m 20m SE)		
d) Rep. of Topography	Yes		
e) Roads/Transportation	Access Rd. gravel 25m S & E		
f) Agriculture	None		
g) Towns/Cities	Gowganda < 1 km		
h) Pollution Sources	None		
i) Power Failures	Seldom		
j) Deviations	Poor windbreak especially on Lake side vandalism		
k) Advantages	Remote, representative		
l) Rating	Good (improve windbreak on lake side cut grass 2x year)		
II OPERATIONS			
a) Condition of Instr.			
- Present	Good		
- Past	Good		
b) Understanding			
- Has manual	Yes		
- Read manual	Yes		
- Understands Protocol	Yes		
c) Follows Protocol			
- Instr. Checks	Yes		
- Sample Handling	Follows protocol		
- Cleaning	Does not clean sensor grids		
- Storage (sample)	In insulated box		
- Std Gauge Protocol	Follows protocol		
d) Attitude	Very good		
e) Reaction to Problems			
f) Submission Forms	Filled out completely		
g) Retraining Needed	Operator unsure of sampling procedures should be retrained		
h) Deviations			
i) Advantages			
j) Rating	Excellent		

TABLE 3.3

Guidelines for the Completion of "Summary - Phase II Site Audit Findings"

Component	Guidelines
I SITING	
a) Windbreak	At how many degrees of the compass is there a windbreak and describe type?
b) Ground Cover	Good ground cover is cut grass or moss; poor ground cover is exposed soil.
c) Obstructions	No object should be within 2.5 times object height to sampler.
d) Rep. of Topography	The topography and vegetative ground cover should be representative of surrounding area (50 km).
e) Roads/Transportation	No major transportation line (road/railway) within one kilometer of site as it may be a contamination source.
f) Agriculture	No agriculture which may provide a contamination source within one kilometre of the site.
g) Towns/Cities	No urbanized areas close to the sampling site (distance depends on size of town/city).
h) Pollution Sources	No minor pollution sources within 1 km (e.g. sewage lagoons, salt and sand piles, gravel pits). No major pollution sources within 50 km (power plants, smelters, open pit mines, pulp and paper plants, etc.).
i) Power Failures	How many power failures are there per year?
j) Deviations	What are the deviations of the site from the APIOS siting criteria?
k) Advantages	What are the advantages of the site?
l) Rating	Objective evaluation based on finding from items (a) to (k) above.
II OPERATIONS	
a) Conditions of Instr. - Present - Past	Findings of tests and observations carried out during the site audit to determine the past and present performance of the instruments. The information is based on calibration and configuration checks, operator comments and auditor's observations.
b) Understanding - Has Manual - Read Manual - Understands Protocol	Understanding by the operator of procedures. Has he read the APIOS manual, does he understand it, does he understand the sampling protocol?
c) Follows Protocol - Instr. Checks - Sample Handling - Cleaning - Storage (sample) - Std.Gauge Protocol	Does the operator check the performance of the instruments, handle the sample as per protocol, clean the required components properly (knife edge, gasket), store sample in a location that would prevent sample degradation and follow only updated sampling protocols?
d) Attitude	Operator's attitude towards the procedures that he/she must follow and towards the APIOS program in general.
e) Reaction to Problems	Does the operator get in touch with the regional technologist promptly if a problem is noted?
f) Submission Forms	Are the submission forms filled out properly and completely?
g) Retraining Needed	Is the operator following most current procedures? Is retraining required?
h) Deviations	What procedures performed by the operator deviate from current APIOS operator sampling protocol?
i) Advantage	Site operations advantages (e.g. attitude, protocol followed).
j) Rating	Objective evaluation based on the findings from (a) to (i) above.

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TABLE 3.4

APIOS Ranking Criteria

Rating	Site	Operator
Excellent	An excellent site should meet all siting criteria. It is easily accessible year-round and has no record of any vandalism.	An excellent operator is one who follows APIOS handling procedures at all times. Samples are collected as scheduled, routine instrument checks are made, and detailed log books are maintained. The operator maintains an interest in the program and regards his/her role as an important function. The excellent operator is one who goes out of his way to ensure the collection of quality samples. These operators frequently participate in special studies.
Good	These sites meet the majority of siting criteria. Any deviations from siting criteria do not significantly affect the integrity of samples collected. Examples of this category might include sites that do not have windbreaks on all compass points; sites located near agricultural areas; sites that have accessibility problems during certain times; or sites that may have objects <2.5 times the height away from the sampler (but not <1 time the height away).	A good operator follows APIOS procedures. Samples are collected, routine instrument checks are made, and a log book is maintained. The operator may not be sincerely interested in the program but procedures are followed as required.
Marginal	These sites need improvement in order to be considered a good site. Examples might be sites with marginal ground cover, or sites with object(s) near the sampler (1 time the height) that may affect the sampler occasionally. Data from these sites should be closely scrutinized.	Marginal operators do not always follow standardized procedures. They occasionally forget to change samples and keep sketchy log books, if any. The low interest of these operators, combined with their performance, do not allow the collection of quality data on a regular basis.
Poor	These sites should either be removed or significantly improved. They do not meet important siting criteria and samples are routinely contaminated. Data collected is unreliable.	Operators in this category do not follow procedures and maintain no interest in the program. If performance cannot be upgraded, then an alternative operator should be immediately located. If no other operator can be found, consideration should be given to removing the site.

TABLE 3.5

Summary of Site Audit Ratings

Siting / Operations	Excellent	Good	Marginal	Poor
Excellent	E.L.A.	Gowganda Merlin Forbes Twp	Whitman Crk.[1]	
Good	Dorset[2] Quetico Centre[6]	Port Stanley Pickle Lake[7]		
Marginal		Coldwater[4]		
Poor			Winisk[8]	
Unrated			Whitney[3]	Ear Falls[5]

1. Unreliable power source, numerous events missed.
2. To reduce influence of windblown contamination, parking lot should be paved.
3. Good if ground cover improved.
4. Evaluate influence of limestone quarry; retrain operators immediately.
5. Many deviations, site to be reviewed by QA Coordinator.
6. Operator needs upgrading.
7. Obstructions (trees) should be removed. New operator to be trained.
8. Poor operator; should be replaced.

evaluated. Action to correct the faults and/or qualify the data collected at these sites should be taken.

1. Ear Falls

The cumulative monitoring site at Ear Falls was rated as "poor" due to numerous deviations from the APIOS siting criteria. These deviations include:

- poor ground cover (gravel & dirt)
- on-site obstructions include two coniferous trees 10m NE and a gasoline holding tank 8m NE
- proximity to a small industrial park (3 km W)
- frequency of vehicular traffic near the gasoline holding tank
- location of site (adjacent to a utility garage and storage area)

It is strongly recommended that the data collected to date be carefully evaluated and this site be relocated in order to collect more representative samples.

2. Winisk

The operations component of the Winisk site was rated as poor. The Sangamo collector was in poor condition at the time of the audit. The GFIC (ground fault interruptor circuit) had tripped, the fuse was blown, one of the sensor grids was broken, the clutch was set too high and the old knife edge collar (with a gap) had not been replaced.

Historical data from this site should be carefully examined. The auditor suspects that bulk samples were being collected at this site during the last few months (if not longer). Samples are often collected weeks and even months late. The operator lacks interest and has a poor attitude towards the APIOS programme. As well, he does not follow any of the documented sample handling procedures.

Deviations from the siting criteria include the proximity of the site to the snowmobile road and the airport. However, given the remoteness and operator accessibility, it is a reasonable compromise. The site could be improved by limiting the snowmobile traffic.

Operator and communication problems at this site are extreme and lead to an overall unacceptable rating. The auditor believes that it would be very difficult to train this operator due to attitude,

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communication and other problems. It is recommended that a new operator be found and thoroughly trained, otherwise the site should be removed.

Some general observations made during the audit are discussed below:

1. The majority of the operators audited have shown marked improvements in the performance of the sample handling procedures outlined in the APIOS Technical and Operating Manual (Bardswick, 1983). Most technologists have either retrained, upgraded and/or reviewed the current operating procedures with their operators. At some sites, the "procedural short list" from the manual has been posted near the instruments. This allows the operator to quickly check that he is following the procedure correctly. Posting procedural short lists should be considered at all sites.

2. The following inconsistencies were noted in sampler configuration.

   a) The southwestern and central regions had no aluminum foil wrapped around the collection vessels to reduce sample loss due to evaporation.

b) Aerochem Metrics dry buckets were still in place in the northwestern region. This was the only region utilizing these buckets.

Uniformity of instrument configuration throughout the network should be instituted. Inconsistencies in configuration from region to region should be assessed by the QA Coordinator for their effect on sample quality.

3. Table 3.6 summarizes the instrument checks performed during the instrument audits. In general, most instruments were operating within the specifications set out by APIOS. However, the co-located Sangamo Type A precipitation collector in Dorset requires immediate attention.

4. To improve the seal between the collector hood and the bucket of the cumulative precipitation collectors, new gaskets have been attached to the underside of the Sangamo/M.I.C. hoods at all cumulative sites (except Dorset because of an on-going precision study). These new gaskets provide a tight seal and prevent both sample loss due to evaporation and contaminants from entering the sample collection containers.

5. Revised site documentation for the central region has not yet been completed. This should be carried out as soon as possible.

TABLE 3.6

Instrument Performance Audit Summary

Region: Central

Site	MIC Serial #	Orifice Height	Collector Area	Level	Hood Movement	Instrument Delay Time (sec)	Instrument Sensitivity	Sensor Grid Condition	Clutch Adjustment	Limit Switch Condition	Gasket Seal	Comment	Storage Gauge Height	Storage Gauge Orifice Size	Storage Gauge Level
Whitney	MIC Type A	2 m	Round 20 cm	Yes	-Movement smooth -Hood does drop on knife edge	100	200 KΩ	Good	>35 lbs.	-Needs adjustment -Too much pressure on support bracket	Good -New gasket installed	Tech installed mesh screen on storage gauge to keep debris & birds out	1.32 m	Round 20 cm	Yes
Dorset	Primary MIC Type A	1.95 m	Round 20 cm	Yes	Good	79	200 KΩ	Good	>35 lbs.	Good	Good -Old gasket used for special studies		1.26 m	Out of round	No
	Secondary MIC Type A	1.95 m	Round 20 cm	Yes	-Not smooth -Drops suddenly	86	354 KΩ	Good	>35 lbs.	-Needs adjustment -Improper contact	Good	Sangamo • Off switch not working • Motor runs on after instrument is turned off	1.24 m	Out of round	No
Cold-water	MIC Type A	2 m	Round 20 cm	Yes	Good	86	260 KΩ	Good	14 lbs.	Good	Good -New gasket		92 cm	Out of round	Yes

TABLE 3.6 (cont'd)
Instrument Performance Audit Summary

Region: Northwest/Northeast

Site	MIC Serial #	Orifice Height	Collector Area	Level	Hood Movement	Instrument Delay Time (sec)	Instrument Sensitivity	Sensor Grid Condition	Clutch Adjustment	Limit Switch Condition	Gasket Seal	Comment	Storage Gauge		
													Height	Orifice Size	Level
E.L.A.	MIC Type A	2 m	Round 20 cm	No	Good	80	200 KΩ	Good	>30 lbs.	Good	Good -New gasket	*Foil wrapped around long tube *Motor humming	1.40 m	Round 28 cm	Yes
Ear Falls	MIC Type A	2 m	Round 20 cm	Yes	-Hood drops on both wet & dry side	80	N/A	Good	20 lbs.	-Needs adjustment -Too much pressure on limit switch bracket	Good -New gasket	*Foil wrapped around long tube	1.50 m	Round	Yes
Quetico Centre	MIC Type A	2 m	Round 20 cm	Yes	Good	87	200 KΩ	-Hot to touch -One grid blackened	20 lbs.	Good	Good -New Gasket	*Foil wrapped around long tube			
Pickle Lake	MIC Type A	2 m	Round 20 cm	Yes	Good	110	N/A	-One grid blackened	>35 lbs.	Good	Good -New gasket	*Foil wrapped around long tube	1.30 m	Round 30 cm	Yes
Winisk	MIC Type A	2 m	Round 19 cm	No	Good	30	400 KΩ	-One grid broken	>35 lbs.	Good	Good -Old knife edge collar	*GFIC tripped & fuse blown -One socket exposed to moisture			
Gowganda	MIC Type A	2 m	Round 19.5 cm	Yes	Good	35	23 KΩ	Good very warm	>35 lbs.	Good	Good -New gasket		1.30 m	Round 29.5cm	Yes

TABLE 3.6 (cont'd)

Instrument Performance Audit Summary

Region: Southwest

Site	MIC Serial #	Orifice Height	Collector Area	Level	Hood Movement	Instrument Delay Time (sec)	Instrument Sensitivity	Sensor Grid Condition	Clutch Adjustment	Limit Switch Condition	Gasket Seal	Comment	Storage Gauge Height	Storage Gauge Orifice Size	Storage Gauge Level
Merlin	MIC Type A	1.99 m	Round 20 cm	Yes	Good	106	100 Ω	Good	15 lbs.	Good	Good -New gasket		1.48 m	Round 20 cm	Yes
Port Stanley	Primary MIC Type A	1.93 m	Round 20 cm	Yes	Good	95	40 Ω	Good	16 lbs.	Good	Good -New gasket		1.61 m	Not round 29.2 cm 28.8 cm	Yes
	Secondary MIC Type A	1.96 m	Round 20 cm	Yes	-Not smooth -Jerks	90	100 Ω	Good	16 lbs.	Good	Good -New gasket	*GFIC trips frequently up to 3 x per month	1.73 m	Round 28.8 cm	Yes

TABLE 3.6 (cont'd)

Instrument Performance Audit Summary

	Aerochem Metric						Rain Gauge		
Site	Sampler Orifice	Level	Comments	Gasket Seal	Gasket Condition	Sensor Condition	Orifice Height	Level	Clean
Forbes Twp. Primary	Round 28.5 cm	Yes	- On/off switch installed - Dry bucket still in place	Good	Good	Good	43 cm	Yes	Yes
Forbes Twp. Secondary	Round 28.5 cm	Yes	- On/off switch installed - Dry bucket still in place	Good	Good	Good	44 cm	Yes	Yes
Whitman Creek	Round 28.5 cm	Yes	- Power problems - Many events missed	Good	Good	Good	76.5 cm	Yes	Yes
Quetico Centre	Round 28.5 cm	Yes	- Dry bucket in place - Water dripping from sensor head	Poor	Moisture on inside of gasket	Good	42.5 cm	Yes	Yes

(Record Number Corrected)

3.2 Technologist Performance

The APIOS technologists carry a major portion of the responsibility for ensuring that the network operating procedures are correctly carried out. They must ensure that the instruments are working properly and that all relevant data are recorded and reported.

During the Phase II Audit, two of the regional technologists were visited, one in the northwestern region and one in the central region. The findings of the technologists' audit indicate that the regional technologists were following operating and technical procedures as described in the APIOS Technical and Operating Manual (Bardswick, 1983).

The technologists maintain close communication with the operators in their region through frequent telephone contact and site visits. Event sites are visited once a week, and cumulative sites at least once a month in the central region, and once every two months in the northwest region. The technologists, where possible, meet with the operators during these visits and discuss sampling and instrument problems. They also provide their operators with literature on "Acid Rain", such as MOE publications, articles from periodicals and newspapers, and will answer any questions the operators may have. The operators find these publications and discussions informative and technologists should be encouraged

to participate in this type of information exchange. It is recommended that the technologists continue to maintain close communication with operators, encourage operators to contact them for any reason, and try to co-ordinate their site visits so that they meet with the operators as often as possible.

Technologists have either reviewed operating procedures or retrained their operators within the last four months. Although operators were, for the most part, following standard operating procedures, it is recommended that the technologist carry out a procedures audit at least twice a year to ensure that operators are following the current protocols. Technologists should ensure that the operators are not contaminating the sample while performing these procedures.

In the northwestern region where sites are widespread, and the visit frequency is low (every few months) due to travel restraints, the regional technologist requires duplicates of operator sheets, monthly site summaries (see Figure 3.1) and log books. One copy remains at the site and the second copy is sent to the technologist. The purpose of this is two-fold:

a) It allows the technologist to get an overall view of what is happening in the region, detect any problems, and schedule site visits.

FIGURE 3.1

Operator Monthly Site Summary Sheet

Collection Period									
Operators Cumulative Log Sheet			From:		To:		Site Name:		
Instrument	Date	Time	Operation Check	Storage Gauge		Volume (L)	Time (Hrs)	Rotameter (lpm)	Comments-Observations
				Depth	Temp.				

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b) It provides a QC check to ensure that the operator sheets are filled out correctly and completely and that all relevant sample information is documented, e.g. identifying potential sources of sample contamination, instrument malfunctions, etc.

It is recommmended that this system be adopted by the network where sites are infrequently visited by technologists due to time and travel restraints.

The northwestern regional technologist has also developed Quality Assurance Activity Log Sheets (see Figures 3.2, 3.3) for the cumulative and event QA activities carried out in the region. This system enables the technologist to plan QA/QC activities necessary to meet the network requirements and at the same time monitor the effectiveness of the QA/QC system in his region. This system should also be considered for adoption by the network.

The northwestern Regional Office provides the regional technologist with a student for two to four days a week. The majority of the student's time is spent on sample processing (precipitation samples and filters). Initially, the technologist should check all of the work carried out by the student (e.g. checks field submission sheets, filter loading and unloading procedures, etc.) to ensure that: a) the student has been trained adequately and b) the quality of the work is acceptable.

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FIGURE 3.2

QA Activity Log Sheet - Event Sampling

Quality Assurance Activity Log - Event Sampling

Region _____ Year _____ Technician _____

Activity	Sent out or Requested	Done			
Blank Bags	June				
	Sept.				
	Dec.				
	Mar.				
Handling Filter Bags	June				
	Sept.				
	Dec.				
	Mar.				
	Site	Forbes 6081	Otter Island 6111	Quetico Centre 6071	Fernberg 6051
Operator Audit					
Field Blanks and Duplicates	Mar.				
	Apr.				
	May				
	June				
	July				
	Aug.				
	Sept.				
	Oct.				
	Nov.				
	Dec.				
	Jan.				
	Feb.				
Composites	Feb.				
	May				
	Aug.				
	Nov.				

FIGURE 3.3

QA Activity Log Sheet - Cumulative Sampling

Quality Assurance Activity Log - Cumulative Sampling

Region _____ Year _____ Technician _____

Sent out or Requested	ACTIVITY										
	Blank Bags	Handling Filter Blanks	Volume Measurement Checks	Composites							
				6011	6121	6031	6041	6051	6071	6091	6111	6061
Jun.												
Sep.												
Dec.												
Mar.												
Operator Audit 1984												

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The technologist performs scheduled maintenance, repairs, calibrations, QA/QC activities, data screening and validation, upgrading of sites and arranging operator and site visits. The technologist feels, however, that the "hands on" training he received on some instrumentation was inadequate (specifically, the sequential sampler and modified Aerochem Metric sampler). This technologist should be retrained on some instrumentation and the auditor suggests that this retraining be carried out in conjunction with the quarterly APIOS Technologist meeting.

The APIOS Technical and Operating Manual (Bardswick, 1983) lists spare instrument parts that the technologists should have on hand to be able to quickly maintain their instruments. This list is based on maintenance requirements for five precipitation collectors:

1	precipitation sampler	1	motor
2	printed circuit boards	10	limit switches
4	sensor grids	1	gasket
2	capacitors		

The technologists were found not to comply with this guideline. The technologists either did not order sufficient supplies on their 6 month request forms, or when they did run out of a particular item they waited until the last moment to notify the Head Office Technologist. As a result, instrument downtime is longer than necessary

due to the length of time required for delivery of parts from Head Office; often two weeks are required to receive the necessary parts for repair of samplers. In order to maximize data completeness by reducing downtime, technologists should ensure that they have on hand at least the recommended supply of spare parts as a minimum at all times.

The technologist in the central region is responsible for the operation and maintenance of a special studies site in Dorset. This involves operating and maintaining many co-located instruments such as sequential samplers, low volume air samplers, daily and cumulative precipitation samplers, gauges, continuous monitors, as well as conducting various on-going special studies.

The majority of his time is spent collecting, processing and documenting APIOS routine and special studies samples. With the additional responsibility of installing, operating, maintaining and co-ordinating long and short-term special studies, the technologist is often unable to perform regularly scheduled preventive maintenance procedures, and as a result some of the instruments in this region have not had preventive maintenance carried out. It is essential that all instruments be serviced and calibrated on a routine basis to ensure reliability and accuracy. The instruments in this region should be serviced and calibrated when required. If the technologist is unable to carry out this task then manpower should be made available to do so.

Canada Soil Survey Committee

The technologists visited during the audit (Phase I and Phase II) have proven to be a real asset to the APIOS programme. Because of the unpredictable nature of field work, these technologists often make valuable subjective decisions regarding the operations of instruments, performance of operators, procedures for data handling and relevant data recording. They were found to be conscientious and concerned about their duties and generally their performances have ensured the generation of good quality data.

3.3 Performance Audit of Data Handling and Validation Procedures - Daily Air Concentration Data

Data validation and screening systems are used to evaluate the raw data before including them in the final database. A number of screening techniques, checks and statistical routines are run on the data to flag unusual or suspect data. A careful scrutiny of these suspect data is performed before the decision to include these data in the database is made. Specific data validation procedures have been developed and documented for daily ambient air data and are described elsewhere (Kirk, 1984). Basically, the validation procedures utilize two approaches. The first approach is to apply gross limit checks to identify unlikely values and the second approach is to examine the sample structure by principal component analysis.

The performance audit checked whether the documented screening and validation checks were being properly carried out. Errors in the data handling system were detected with the use of non-routine manual screening techniques.

The audited data set consisted of data collected at Fernberg and Longwoods during the months of February, March, June and July, 1982.

A description of the checks performed, along with the findings, are described below.

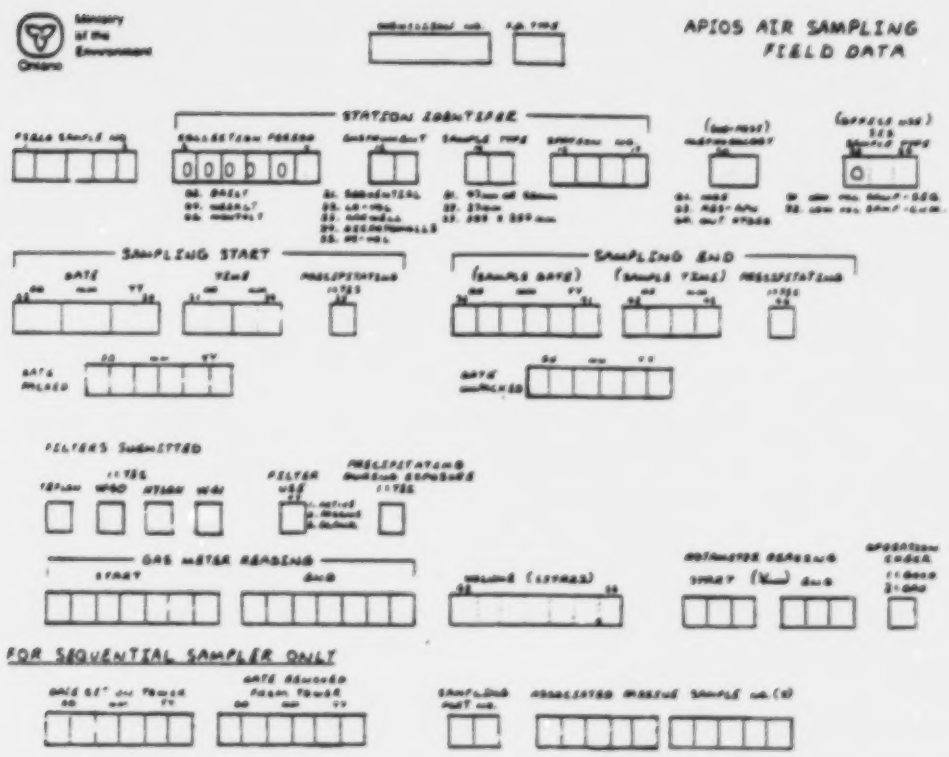
1. Check - Field sheets were screened manually to ensure that they had been filled out completely and correctly by the regional technologist. The field sheets contain information about the samples submitted, such as the site name and number, sampling period, filter type, gas meter reading, sample volume, rotameter reading, sampling port number, sampling start and end dates, associated passive sample numbers and field comments about the sample. A blank air sampling field data sheet is shown in Figure 3.4.

Findings - Fernberg

- All field sheets for the months of February and March were missing associated passive sample numbers and sample type (e.g. active, passive or blank).

FIGURE 3.4

APIOS Air Sampling Field Data Sheet



- Filter lot numbers for Teflon, Nylon and Whatman 41 filters were missing for the period February 1-10, 1982 and the filter lot number for Teflon filters was recorded as a "question mark" for the period June 22 - July 6, 1982.

- Associated passive sample numbers were recorded incorrectly on two occasions:

Sample Number	Reported Associated Passive Number(s)	Actual Associated Passive Number(s)
95441	95432/95448	95440/95448
95443	95442	95448

- All field sheets for the study period were missing initial and final rotameter readings and operation check.

- Some switched filter dates for "set on tower" are recorded incorrectly. The switched filters are left on the tower for a two week period, the first week in port #8 and the second week in port #1. On some field sheets the date "set on the tower" was recorded as the first day of the second week (however, this date is not entered into the database).

- All sample dates, times, station identifiers and sampling port numbers were recorded correctly.

Longwoods

- Sampling end date for sample number 15347 was recorded incorrectly as 15/2/82. This was a two day sample beginning on 14/2/82 and ending on 16/2/82 (sample volume = 52680 l).

- All station identifiers, sampling port numbers and associated passive numbers had been recorded correctly.

- Some data recorded as "date set on tower" were incorrect for switched filters (see Fernberg).

Manual screening of field data sheets prior to submission would have prevented omissions and errors. It is recommended that the technologists visually check the field sheets for missing information, incorrect dates, incorrect times and illogical coding prior to submission. These manual screening techniques are described in the APIOS Technical and Operating Manual along with procedures to be followed when filling out these data sheets. When an omission or error is found, a revised or corrected field sheet should be submitted.

2. Check - Field sheets were checked against 1982 Daily Ambient Air Concentration Listings (MOE, 1984). This involved comparing the data recorded on the field sheet to the APIOS published data and checking for transcription errors and omissions.

Findings - Transcription errors were not found. In all cases, the information listed in the database complemented the field sheets. Only one instance of a data point omission was found in the published report. A field sheet and LIS output for a sample collected at Fernberg (February 9-10, 1982; #30139) was found but the corresponding concentration listings were not reported.

3. Check - Summary of field and office comments. This involved tabulating the office and field comments for all daily air concentration measurement sites for the period January 1 to December 31, 1982. This table provides a quick overview of the types of comments which are being appended to analysed samples. Frequently, recurring field or office comments can sometimes be good indicators of sample contamination, poor instrumentation or non representative siting.

Finding - Table 3.7 summarizes the frequency of comment codes. Dorset had the greatest number of sampler malfunctions 35 of 334 samples (10%) and abnormal sampling periods 16 of 334 samples (5%). However, the majority of these malfunctions did not affect the samples. Since the Dorset technologist is on-site, any sequencing problems were always

TABLE 3.7

Frequency of Field and Office Comments - Daily Dry Data
1982

Site	No. of Records	% Data Completeness	Field Comments											Office Comments				Lab Comment — Result Remark Code							
			A	B	C	D	E	F	G	H	I	J	K	F	P	Z	X	*	>	< T	< W	A	U	P	< P
Longwoods	343	94	3			1			2	3	9	1	2	2		6	3	86	71	4	11		18		
Dorset	334	91	35				2		5	1	6	35				16		21	16	58	122		8		
Charleston Lake	340	93	16	1		6			7				1	2		8		36	51	21	47		23		
Fernberg	317	87	5	5	1		3				2			5		3		28	8	52	151		27		

Field Comment Code Index

A - Sampler Malfunction
B - Known Hydro Failure
C - Suspected Hydro Failure
D - Known Filter Pack Leak
E - Suspected Filter Pack Leak
F - Gas Meter not equal to Rotameter
G - Flow Line Problems
H - Known Contamination
I - Suspected Contamination
J - Heavy Dew or Fog
K - Sample not Submitted

Office Comment Code Index

F - Data invalidated - Flow volume rate less than 10,000 l per day
P - Passive missing - Average passive results used as blank correction
Z - Abnormal sampling period
X - Sample lost

Result Remark Code Index

> - Actual result greater than value reported
< - Actual result less than value reported
<T - Actual result less than criterion of detection
<W - No response, minimum possible result reported
A - Approximate value
U - Unreliable result
P - Not corrected for passive
<P - Not corrected for passive - Reported value is a detection limit
* - No data reported

fixed before a new pack began sampling. Charleston Lake had the second highest record of these occurrences, 5% (sample malfunctions) and 25% (abnormal sampling periods). Fernberg reported the largest number of invalid data due to insufficient sample volume (<1000 litres per day) 2%.

To determine the frequency of occurrences per site due to hydro failure, contamination or flow volume problems, field comment codes associated with each of these problems were combined and a percentage calculated. The results are tabulated in Table 3.8.

4. Check - Data Validation Procedures. This involved determining if the procedures for validating daily dry data described in Kirk (1984) have been correctly executed. These procedures involve qualifying sample records by three methods.

1. Field comments - which are appended to the sample records at the point of collection to reflect sample quality and possible sources of contamination.

2. Office comments - which are appended to sample records to indicate failure of specific integrity tests or sample representativeness.

3. Validation flags - which are appended to individual analytical results if outliers are detected or gross limits fail.

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TABLE 3.8

Frequency of Field Comments Per Site for Hydro Failure, Flow Volume Problems and Contamination
Event Air Sampling Network (1982)

Site	% Hydro Failure B+C	% Flow Volume D+E+F+G	% Contamination H+I
Longwoods	0	<1	3
Dorset	0	<2	2
Charleston Lake	<1	4	0
Fernberg	<2	<1	<1

Field comment codes appended to samples from Longwoods and Fernberg during the study period (e.g. February, March, June and July, 1982) were investigated to determine if the appropriate office comments and validation flags had been applied. Field data sheets, LIS outputs and reported data concentrations were compared. Samples which exceeded the gross limits were tabulated and the data examined.

Findings - The procedures for qualifying data were for the most part correctly executed. Some modifications may be required when reporting data with the following field codes: I (suspected contamination) and H (known contamination). When a single filter (Nylon, Teflon or Whatman 41) is potentially contaminated while being unloaded due to improper filter handling techniques (e.g. dropped on floor, touched by technologists bare hand, etc.) a "result remark code" should be appended to the analytical result associated with the analysis of that filter rather than to the entire sample, i.e. for nylon filter a remark result code should be appended to the N-HNO_3 result. This also applies to a single filter with the code H (know contamination) appended to it. Table 3.9 summarizes the field comments investigated.

Tables 3.10 and 3.11 summarize samples in which a parameter exceeded the upper or lower gross limit. The following observations were made:

TABLE 3.9

Data Qualification Check

Site	Field Number	Field Comment	Office Comments	Result Remark	Auditors Comments
Fernberg	30162	A	Z		Sampler malfunction, two day sample, March 7-9, 1982 Sample volume = 50040 litres. All appropriate codes and comments appended.
	95480	I			Suspected filter contamination, Teflon filter dropped while unloading. This was a passive filter - analytical results from LIS $N\text{-}NH_4^+$ = !EF (equipment failure) $N\text{-}NO_3$ = .25 <W, $SO_4^=$ = 1.25 <W. All appropriate codes and comments appended.
	90152	E			Suspected filter pack leak. Sample from March 13 08:00 hrs. to March 14 09:00 hrs 1982.
Longwoods	15342 15343 15345 15362 15364	I I I I I		U	Suspected contamination of nylon filters all $N\text{-}HNO_3$ results should be flagged to reflect this.
	15347	H	Z		Two day sample, February 14-16, 1982 known contamination of nylon filter - not flagged as unreliable. $N\text{-}HNO_3$ result should be flagged.
	15352	G			Technologists comment on field sheet - "twist lock nozzle cracked at inlet port - incorrect volume reported 23920 litres". Appropriate comments appended.
	15501	D			Technologist comment on field sheet - "Tygon tubing separated at coupler joint - volume reported is actual sample volume". Appropriate comments appended.

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TABLE 3.10

Gross Limit Checks - Lower Limit

Feb., Mar., June, July 1982
Fernberg and Longwoods

Site	Parameter	Sample Number	Concentration $\mu g\ m^{-3}$	Result Remark	Field Comment	Office Comment	Auditor's Comment
Fernberg	SO_2	30165*	0.00				P>A
"	"	30152	"				P>A
"	"	10677*	"				P>A
"	"	95433*	"				P>A
"	"	95441*	"				P>A
"	"	95449*	"				P>A
"	"	95455	"				P>A
"	"	95457*	"				P>A
"	"	95459	"				P>A
"	"	95461	"				P>A
"	"	95465*	"				P>A
"	"	95473*	"				2nd Passive Value UI!
"	"	95481*	"				A>P
"	"	95482	"				LIS not available to auditor
"	"	95489*	"				P>A
"	"	15471*	"				P>A
Longwoods	"	15475	"				P>A
"	"	15487	"				P>A
"	"	15501*	"		D		1st Passive Value UI!
"	"	15512	"				P>A
"	"	15517*	"				P>A

* = Port # 1/8

UI! = no data, undetermined interference (laboratory code)

P>A = passive result greater than active

TABLE 3.10 (cont'd)

Gross Limit Checks - Lower Limit

Feb., Mar., June, July 1982
Fernberg and Longwoods

Site	Parameter	Sample Number	Concentration $\mu g\ m^{-3}$	Result Remark	Field Comment	Office Comment	Auditor's Comment
Fernberg	$N\text{-}NO_3$	30152	0.00	<T			
"	"	30133*	"				<W on LIS output P>A
"	"	30135	"	<T			
"	"	30136	"	<T			
"	"	95425*	"				P>A
"	"	95433*	"	<T			
"	"	30124*	"	<W			
Longwoods	"	15352	0.00		G		<T on LIS output
"	"	15353	"				<W on LIS output
"	"	15354	"				P>A
"	"	15355	"				P>A
"	"	15358*	"				P>A
Fernberg	$N\text{-}HNO_3$	95425*	"				P>A
"	"	95426	"				<T on LIS output
Longwoods	SO_4 =	15471	"				Should be 0.23 $\mu g\ m^{-3}$
"	"	15358*	"				P>A
"		15496	"				P>A

* = Port # 1/8

<T = reported at the detection limit

<W = no response, minimum possible result recorded

TABLE 3.11

Gross Limit Checks - Upper Limit

Feb., Mar., June, July 1982
Fernberg and Longwoods

Site	Parameter	Sample Number	Concentration $\mu g\ m^{-3}$	Result Remark	Field Comment	Office Comment	Auditor's Comment
Fernberg	$N\text{-}NO_3$	95428	0.09				
"	"	95460	0.26				
"	SO_2	30174	16.96				
Longwoods	"	15497	31.85				
"	SO_4	15347	14.93	U	H	Z	Nylon filter-H
"	"	15503	40.93				
"	$N\text{-}NH_4$	15344	9.057	>			
"	"	15345	9.426	>	I		Nylon Filter-I
"	"	15346	9.509	>			
"	"	15347	4.744	>	H	Z	Nylon Filter-H
"	"	15348*	8.944	>			
"	"	15362	9.140	>	I		Nylon Filter-I

* = Port # 1/8

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- If an active result with a remark code is less than a passive result, the active is reported as "0" and the remark code is removed. However, for samples 15352, 15353 and 95426 the result remark codes (<T, <W) appended to analytical results on the L.I.S. output did not appear in the Daily Ambient Air Concentration Listings (MOE, 1984).

- With the exception of one instance, all exceedances of the upper limits were not flagged as unreliable. It should be noted that all exceedences of the upper limits were studied by a staff scientist.

- For all instances where the passive result was equal to or exceeded the active result a zero was reported.

5. Check - Passive Correction Calculations. This involved determining if the passive correction calculations were executed properly. Filters in sampling ports 2 to 7 are corrected using the equation shown below. Twenty-five percent of data from the study period corrected using this calculation was spot checked.

$$\underset{(\mu g\ m^{-3})}{\text{Reported Conc.}} = \frac{\text{Active Result -6/7 Passive Result } (\mu g\ fil^{-1})}{\text{Sample volume } (m^3)}$$

Switched filters (ports 1 and 8) are left in the field for a two-week period and are corrected using the equation shown below. All

switched filters from the study period were examined for passive correction errors.

$$\text{Reported Conc.}_{(\mu g\ m^{-3})} = \frac{\text{Active Result} - P_1 - 6/7\ P_2\ (\mu g\ fil^{-1})}{\text{Sample Volume}\ (m^3)}$$

where:

P_1 = Passive Result from week 1

P_2 = Passive Result from week 2

If a passive result is:

1. reported at the detection limit (<T) then a value corresponding to one half the detection limit is utilized for passive correction.

2. reported as no response, minimum possible result reported (<W) then a value of zero is utilized for passive correction.

3. equal to or exceeding the active result then the concentration is reported as equal to zero.

Findings - A few discrepancies (four samples) between the reported concentration and calculated concentration for switched filters were observed and tabulated (Table 3.12). The samples appear to have

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TABLE 3.12

Calculation Errors - Switched Filters

Sample No.	Volume m^3	Parameter	Active Result $\mu g\ fil^{-1}$	1st Passive Result $\mu g\ fil^{-1}$	2nd Passive Result $\mu g\ fil^{-1}$	Calculated Conc. $\mu g\ m^{-3}$	Reported Conc. $\mu g\ m^{-3}$	Comments
30155	23.58	$N\text{-}NO_3$	1.05	.25 < W	.25 < T	0.04	0.06	associated passive numbers not recorded on field data sheets
15470	26.36	$N\text{-}NH_4$	5.10	0.70	.25	0.159	0.171	only 1 associated passive number recorded on field data sheet
		$N\text{-}HNO_3$	8.25	5.25	2.50	0.03	0.14	
		SO_2	60.05	60.05	33.35	0.00	0.33	
15478	26.37	$SO_4^=$	170.00	1.25 <W	1.25<W	6.41	6.45	"
		$N\text{-}HNO_3$	58.75	2.50	5.00	1.97	2.15	
		SO_2	247.00	33.55	56.70	6.25	8.29	
15993	18.63	$SO_4^=$	335.00	1.25	3.75	18.82	18.88	"
		$N\text{-}HNO_3$	25.20	2.50	4.20	1.04	1.16	

been corrected using the wrong passive filter results. Field data sheets for passive and active samples were examined and the associated passive sample numbers for these switched filters were determined. These "switched" errors were found to have originated from the computer program which assigns passive corrections to active results. Because these four samples had "unusual" passive dates, the errors went unnoticed. The error would have been eliminated if the passive numbers themselves, recorded on the field sheets, were used rather than passive dates (presently being used in the networks for validation purposes).

While performing passive calculation checks, it was noted that in some instances an average passive value was determined and the active concentration calculated and reported (Table 3.13) when:

a) a passive filter result was missing due to laboratory equipment failure or undetermined interference; or

b) one of the passive filter results exceeded the active filter result; or

c) a passive sample was not received at the laboratory.

This procedure, which was carried out at the discretion of the database manager, should be documented and included in the Data Management section of the APIOS Technical and Operating Manual. When reporting

TABLE 3.13

Blank Corrections Using an Average Passive Value

Sample No.	Volume m^3	Parameter	Active Result $\mu g\ fil^{-1}$	1st Passive Result $\mu g\ fil^{-1}$	2nd Passive Result $\mu g\ fil^{-1}$	Reported Conc. $\mu g\ m^{-3}$	Comments
95473	22.34	$N\text{-}NH_4^+$	2.30	0.05<T	!EF	0.100	!EF = laboratory equipment failure
15374	27.72	$N\text{-}NH_4^+$	50.00>	!EF	!EF	1.774>	!EF = laboratory equipment failure
15390	28.75	$N\text{-}NH_4^+$	48.50	!EF	0.75	1.649	!EF = laboratory equipment failure
15390	28.75	$SO_4=$	570.00	30.00	NR	18.19	NR = laboratory did not receive sample
15342	28.22	SO_2	420.00	20.00	580.00	13.17	
15348	27.74	SO_2	23.30	580.00	13.30	19.96	
15493	18.63	SO_2	220.00	76.70	UI	9.51	UI = undetermined interference

these data the office comment code "P" (passive filter missing - average passive result used as blank correction) or an equivalent result remark should have been appended.

6. Check - Passive results for the Longwoods and Fernberg sites were tabulated by season for the study period. The mean, standard deviation, range and variance were calculated for each and the data examined.

Findings - (see Tables 3.14 to 3.17) Results with an asterisk (*) indicate that the passive result was greater than an associated active result. The passive SO_2 results are extremely variable and all SO_2 passive results from Fernberg during June and July (1982) were greater than the active results.

Samples No. 15389 and 15397 have SO_4 results reported as 0.25 $\mu g\ filter^{-1}$ which is less than the detection limit of 1.25 $\mu g\ filter^{-1}$.

The variability of passives results should be determined and accounted for in the calculation.

3.4 Performance Audit of Data Handling and Validation Procedures - Cumulative (28-day) Air Concentration Data

Specific data validation procedures have been outlined (Chung, 1984) to screen cumulative ambient air monitoring results. These proce-

TABLE 3.14

1982 Passive Results for Longwood (June, July)

Passive ID	Date Off	Associated Active	NH_4 µg fil^{-1}	NO_3 µg fil^{-1}	SO_4 µg fil^{-1}	HNO_3 µg fil^{-1}	SO_4 µg fil^{-1} (Nylon)	SO_2 µg fil^{-1}	Comment
Detection Limits			0.05	0.25	1.25	0.25	2.5	3.35	
15469	2/6/82	15462 to 15470	.70	.25<W	1.25<W	5.25	36.25	60.05*	*P > A
15477	9/6/82	15470 to 15478	.25	.25<W	1.25<W	2.50	22.50	33.55	
15485	15/6/82	15478 to 15486	.25	.25<W	1.25	5.00	22.50	56.76	
15492	22/6/82	15486 to 15493	.10	.25<W	1.25	2.25	21.20	76.70	
15500	13/7/82	15493 to 15501	.10<T	.25<W	3.75	4.20	31.20	!UI	undetermined interference !UI
15508	20/7/82	15501 to 15509	.40	.25<W	1.25	3.00	27.50	53.40	
15516	27/7/82	15509 to 15517	.05<T	.25<W	1.25<W	2.50	16.20	103.00*	* P > A
		Mean	0.26	.25	1.61	3.53	25.33	63.91	
		Std Deviation	0.23	0	0.95	1.26	6.77	23.62	
		Variance	0.05	0	0.89	1.60	45.80	55	
		Range	0.65	0	2.50	3.00	20.05	69.45	

TABLE

1982 Passive Results for Longwood (February, March)

Passive ID	Date Off	Associated Active	NH_4 µg fil^{-1}	NO_3 µg fil^{-1}	SO_4 µg fil^{-1}	HNO_3 µg fil^{-1}	SO_4 µg fil^{-1} (Nylon)	SO_2 µg fil^{-1}	Comment
Detection Limits			0.05	0.25	1.25	0.25	2.5	3.35	
15341	9/2/82	15334 to 15342	.25<T	.25<T	2.50	5.25	28.80	20.00	
15349	16/2/82	15342 to 15350	.25<T	.50	2.50	8.25	32.50	580.00*	*P > A
15357	23/2/82	15350 to 15358	0.45	1.75*	8.75*	2.75	37.50	13.30	*P > A
15365	2/3/82	15358 to 15366	!EF	.25	1.25	1.25	20.00	10.00	
15373	9/3/82	15366 to 15374	!EF	1.00	3.75	3.50	28.80	26.70	
15381	16/3/82	15374 to 15382	!EF	.50	1.25<T	3.00	36.20	33.30	
15389	23/3/82	15382 to 15390	!EF	.25<T	* .25<T	2.50	28.80	30.00	*less than detection limit
15397	1/4/82	15462 to 15470	.75	.25<W	* .25<W	3.00	27.50	!NR	*less than detection limit
		Mean	0.42	0.59	2.56	3.69	30.01	101.9	
		Std Deviation	0.23	0.53	2.77	2.15	5.50	211	
		Variance	0.05	0.28	7.69	4.63	30.21	445	
		Range	0.50	1.50	8.50	7.00	17.50	570.00	

TABLE 3.16

1982 Passive Results for Fernberg (June, July)

Passive ID	Date Off	Associated Active	NH_4 µg fil^{-1}	NO_3 µg fil^{-1}	SO_4 µg fil^{-1}	HNO_3 µg fil^{-1}	SO_4 µg fil^{-1} (Nylon)	SO_2 µg fil^{-1}	Comment
Detection Limits			0.05	0.25	1.25	0.25	2.5	3.35	
95432	8/6/82	95425 to 95433	.05<T	.25<T	1.25<T	1.00	3.75	50.00*	* P > A
95440	15/6/82	95433 to 95441	.05<T	.25<T	1.25<T	.25<T	1.25<T	63.40*	* P > A
95448	22/6/82	95441 to 95449	.05<T	.25<W	1.25<W	.25<W	1.25<W	5.67*	* P > A
95456	29/6/82	95450 to 95457	.05<T	.25<W	2.50	.75	3.75	66.7*	* P > A
95464	6/7/82	95457 to 95465	.05<T	.25<W	1.25<W	.50	2.50	53.40*	* P > A
95472	13/7/82	95465 to 95473	.05<T	.25<W	1.25<W	.50	1.25<T	40.00*	* P > A
95480	20/7/82	95473 to 95481	!EF [1]	.25<W[1]	1.25<W[1]	.75	3.75	!UI	1 Teflon filter dropped
95488	27/7/82	95481 to 95489	.10<T	.25<W	1.25<W	.25<W	2.50	30.00*	* P > A
95496	5/8/82	95489 to 95497	.10<T	.25<W	1.25<W	1.00	2.50	23.30*	* P > A
		Mean	0.0625	.25	1.38	0.58	2.50	47.94	
		Std Deviation	0.023	0	0.42	0.31	1.08	15.55	
		Variance	0.005	0	0.174	0.09	1.17	242	
		Range	0.05	0	1.25	0.75	2.50	43.40	

TABLE 3.17

1982 Passive Results for Fernberg (February, March)

Passive ID	Date Off	Associated Active	NH_4 µg fil^{-1}	NO_3 µg fil^{-1}	SO_4 µg fil^{-1}	HNO_3 µg fil^{-1}	SO_4 µg fil^{-1} (Nylon)	SO_2 µg fil^{-1}	Comment
Detection Limits			0.05	0.25	1.25	0.25	2.5	3.35	
30132	2/2/82	30130	.20	.25<T	1.25<T	1.50	11.20	10.00	
30117	9/2/82	30134 to 30118	.20	.25<T	1.25<W	.75	6.25	13.30	
30180	23/2/82	30173 to 30165	.05<W	.25<W	1.25<W	.25<W	20.00	26.70*	* P > A
30172	2/3/82	30165 to 30171	.15	.25<W	1.25<W	.75	10.00	16.70	
30164	9/3/82	30157 to 30163	.25	.25<W	1.25<W	1.00	8.75	13.30	
30156	16/3/82	30149 to 30157	.30	.25<T	1.25<T	.75	15.00	70.00	
30140	23/3/82	30133 to 30138	.30	.25<T	1.25<W	.25	10.00	53.40	
10684	30/3/82	10678 to 10683	.05<T	.25<W	1.25<W	.75	30.00	277.00*	* P > A
		Mean	0.19	.25	1.25	0.75	13.90	60.05	
		Std Deviation	0.10	0	0	0.40	7.75	90.30	
		Variance	0.01	0	0	0.161	60.0	8154	
		Range	0.25	0	0	1.25	23.75	267.00	

dures consist of 1) an integrity check of sample analysis and 2) statistical screening of the data for outliers using the Dixon Ratio Test.

In the performance audit non-routine manual checks were performed to determine if the data validation procedures were being utilized properly. The audited data set consisted of data collected at five sites (one site in each of the five regions): Gowganda, Shallow Lake, Uxbridge, Pickle Lake and Smiths Falls for the period January to December of 1982. A description of the checks performed along with the findings are described below.

1. Check - Field sheets were compared to operator sheets to ensure that all information recorded on the operator sheets was transferred and that it was transcribed correctly. The field sheets were also checked for proper changeover dates and proper use of field codes.

The field sheets contain all information pertinent to the samples submitted such as the sampling period, filter type, any problems observed, volume readings, etc. Field and operator sheets were available for all sites with the exception of Pickle Lake (operator sheets were unavailable).

Findings - A summary of the discrepancies found between the field and operator sheets is shown on Table 3.18. In most cases the discrepancies are due to errors in information transfer or missing information. It is recommended that the technologists be made aware of these types of discrepancies and that a system of automatic verification be introduced which would prevent these inaccuracies. This system was also recommended in the Phase I audit (CSC, 1984) and involves comparing a portion (10%) of the operator and field sheets every six months. This would be the responsibility of the QAC. When a discrepancy is found, the technologist is made aware of it and a revised field sheet submitted.

2. Check - Reported data against field sheets. The reported data was checked manually against the field sheets to ensure all data were transcribed correctly. Field sheets and reported data were available for all of the five sites and data for 60 samples were examined.

Findings - A summary of the discrepancies found between the field sheets and reported information is found in Table 3.19. For the most part, information transferred from field sheets to the database was correctly executed with the exception of the data from the Uxbridge site (12 transcription errors were noted). A system of automatic verification should be implemented to minimize this type of problem. If complete and accurate data are to be reported, transcription errors and omissions must be eliminated. The QAC should continue to spot check field sheets and database output particularly from the Uxbridge site.

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TABLE 3.18

Discrepancies Between Field and Operator Sheets

Site	# of Data Sheets Examined	Number of Occurrences: Information Not Transferred From Operator Sheets to Field Sheets	Information Transferred Incorrectly	Sample Changed on Wrong Day	Improper Code Used for Filter Type or SIS Sample Type	Filter Lot Number Not Recorded
Gowganda	12	8	5	4	1	10
Uxbridge	14	2	1	7	3	11
Shallow Lake	12	4	1	0	1	0
Smiths Falls	14	4	0	3	1	10

Note: Pickle Lake excluded; operator sheets were not available.

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TABLE 3.19

Discrepancies Between Field Sheets and Reported Data

Site	# of Data Points Examined	Number of Occurrences			
		Volume not Recorded	Field Codes not Transferred from Field Sheet to Database	Information Transferred Incorrectly From Field Sheets to Database	Incorrect Time Transcribed on Database Output
Gowganda	12	0	0	0	1
Uxbridge	12	0	1	12	
Shallow Lake	12	0	1	0	0
Smiths Falls	12	1	0	0	1
Pickle Lake	12	0	1	3	3

3. Check - Summary of field and office comments. Field, office and laboratory comments for cumulative ambient air monitoring network for the period of January to December 1982 were examined.

Findings - Table 3.20 summarizes the frequency of field, office and lab comments. To determine the frequency of occurrences per site due to hydro failure, sample contamination or flow volume problems, field comment codes associated with each of these problems were combined and a relative frequency was calculated. The results are tabulated in Table 3.21.

4. Check - Data Validation Procedures. Procedures outlined in Data Validation Procedures, Cumulative Ambient Air Monitoring Network (Chung 1984) were examined to determine whether they are being implemented properly. Validation procedures utilized consist of two approaches. The first approach consists of an integrity check in which the sample flow, volume and sampling period are examined and the second is a statistical screening of the data for outliers (using the Dixon Ratio tests).

All reported data from the five sites selected during the period January to December 1982 were screened to ensure proper tags (i.e. Z for sampling period, F for flow volumes) were applied to samples that were not within specified guidelines and 25% of the reported data were randomly checked using the Dixon Ratio test.

TABLE 3.20

Frequency of Field and Office Comments - Low Vol Data (1982)

Site	Number of Records	Field Comments											Office Comments			Lab Comments					
																Result Remark Code					
		A	B	C	D	E	F	G	H	I	J	K	F	Z	X	*	>	<T	<W	A	U
Gowganda	12													4		5	1				1
Uxbridge	12			1										2		11		1	2		3
Shallow Lake	12	3			1		2		1	3			1	1		22		1			
Smiths Falls	12	1	3						2	2			2	3		30	1				2
Pickle Lake	12	1	1					5					3	6		23	2	4	1		1

Field Comment Code Index

A - Sampler Malfunction
B - Known Hydro Failure
C - Suspected Hydro Failure
D - Known Filter Pack Leak
E - Suspected Filter Pack Leak
F - Gasmeter Not Equal to Rotameter
G - Flow Line Problems
H - Known Contamination
I - Suspected Contamination
J - Heavy Dew or Fog
K - Sample Not Submitted

Office Comment Code Index

F - Data invalidated - flow volume not within upper and lower limits (150% and 50% of 2880 litres/day respectively)
Z - Sampling period abnormal - sampling period not within upper and lower limits (29 and 27 days respectively)
X - Sample lost

Result Remark Code

> - Actual result greater than value reported
< - Actual result less than value reported
<T - Actual result less than criterion of detection
<W - No response, minimum possible result reported
A - Approximate value
U - Unreliable result
* - No data reported

TABLE 3.21

Frequency of Field Comments Per Site for Hydro Failure, Flow Volume Problems and Contamination
Cumulative Air Sampling Network (1982)

Site	% Hydro Failure B+C	% Flow Volume D+E+F+G	% Contamination H+I
Gowganda	0	0	0
Uxbridge	8	0	0
Shallow Lake	33	25	33
Smiths Falls	25	17	33
Pickle Lake	17	33	0

All samples had the proper office comment codes appended. Samples which exceeded the upper and lower limits for flow volume (150% and 50% of 2880 litre/day, respectively) were appended with the code "F". Samples which exceeded the upper and lower limits of the standard sampling period (29 and 27 days, respectively) were appended with the code "Z".

The Dixon Ratio test was applied to approximately 25% of the data from January to December 1982. It was found that it is being used correctly to identify outliers in the reported data.

4. SYSTEMS RELATED AUDIT

A systems related audit involves reviewing network operations and systems to determine how well they satisfy the objectives of a monitoring network. The primary objectives of the APIOS monitoring network are the quantification of both wet and dry deposition patterns across the province of Ontario (Chan et al., 1984, 1st revised edition).

Since the Phase I systems audit reviewed, in detail, the overall operating system and QA system of the APIOS network, the Phase II system audit concentrated on an evaluation of the daily air concentration data reporting and validation procedures, recent changes to the network organization, and routine QA/QC procedures with respect to QA objectives.

4.1 Daily Air Concentration Data Validation Procedures and Reporting

The APIOS data validation procedures for the daily ambient air monitoring network have recently been documented (Kirk, 1984) and should be included in the Data Management section of the APIOS Technical and Operating Manual (Bardswick, 1983).

Basically, these procedures involve two editing/screening stages. The first stage involves comparing the database output, in

which omissions or inconsistencies have been noted (e.g. missing sample volumes, abnormal sampling periods, dates, times, etc.), to the field data sheets. This step ensures completeness and accuracy of the data set. The second stage utilizes statistical computerized screening techniques such as gross limit checks and principal component analysis to select unlikely analytical results. These selected results are then reviewed by the database scientist who subjectively decides whether results appear reasonable or not. The data validation system seems to be well conceived and implemented, however, modifications are suggested in qualifying and reporting data.

Use of Comment Codes

As discussed in the performance audit, data with the field comment codes I (suspected contamination) and H (known contamination) often provide misleading information about the quality of the data set. This has been noted when the codes apply to one filter in particular as opposed to the entire set of filters comprising one sample. When this occurs, an appropriate result remark code should be appended to the analytical results of the filter rather than appending the field comment code to the entire data set for the sample.

Inconsistencies in the use of these codes has also been noted where one technologist has used the code I, while another uses the code

H for the same situation, e.g. "dropped nylon filter on floor while unloading filter pack".

The use of these codes (H and I) should be standardized. Any observations which could affect the integrity of any filters in the filter pack should always be included on the field data sheets. These observations have proven to be quite valuable to the database scientist when qualifying data with field comment codes appended.

The letter "P" is utilized as an office comment code and a result remark code. However, the definitions associated with these codes differ. The office comment code "P" indicates that an average passive result was used for blank correction and the result remark code "P" indicates that a sample was not corrected with a passive result. Because these codes have different meanings the same letter should not be used. It should be noted, however, that for the 1982 data the office comment code "P" was never used in the data validation procedure. Therefore, it should have been removed from the 1982 report which describes these codes.

Symbols utilized as office comments codes, field comment codes, and result remark codes should be unique and have precise definitions to avoid ambiguity in interpretation.

When a passive result is not available because of laboratory equipment failure or undetermined interference, an average passive result is utilized for passive correction. When this occurs for a particular parameter in the data set, a result remark code equivalent to the office comment code "P - passive missing, average passive result used for blank correction" should be appended.

The procedures or guidelines utilized by the database scientist in determining whether an active result will be corrected using an average of passive values should be documented and included in the Data Management section of the APIOS Technical and Operating Manual (Bardswick, 1983), as well as Data Validation Procedures (Kirk, 1984).

Reporting Data

Currently, the APIOS network reports data in the form of two or three significant figures for air concentration measurements. The data are calculated by subtraction of a weekly passive filter value from the corresponding actively sampled integrative value for each parameter. Active values less than or equal to the passive value are reported as zero.

The performance audit section of this report reveals that in many instances the passive result was greater than the active result.

It is recommended that re-evaluation of passive correction is in order to determine why passive results are frequently greater than the active results.

The reporting of data should ensure that results are not arbitrarily truncated nor set to zero if active filter results give negative numbers after correction for passive filter contribution. The level of confidence with low level data should be reported to data users in the form of codes attached to specific numbers outlining measurement, method detection criteria and detection limits, and the statistical levels of confidence in numbers. (See the IJC Bulletin on detection limits, Appendix III.)

4.2 Network Organization and Operation

The recent change to regionalization of field operations has an important impact on the quality of the data collected and produced by the network. From an operational point of view, it will ease logistical constraints of field operations by allowing the APIOS technical people access to other ministry resources. It should also improve many aspects of the field program by providing additional support to APIOS field activities, particularly in the remote areas of the province because other ministry employees will be able to assist in sample collection and maintenance.

However, APIOS and regional managers must take appropriate action to ensure that APIOS technical staff concentrate their efforts on the APIOS programme to ensure continuity and comparability within and between regions.

Reduction in the technologists travelling time (by co-ordinating site visits with other ministry activities) should improve staff morale and allow technologists to spend time on other aspects of the APIOS network such as processing and interpretting QA/QC information and data validation procedures. Regionalization will require work on the part of the APIOS head office staff in terms of support, organizational requirements, co-ordination and quality control.

The emphasis on network QA/QC must continue. QA/QC and overall network operating systems must improve in order to implement the proper QA/QC monitoring procedures to ensure the system is in control. It will be the responsibility of the QA Coordinator to ensure that the field personnel are meeting their APIOS field requirements by designing and implementing a system to monitor field QA/QC procedures. In particular, his functions with respect to corrective action monitoring, routine QA/QC assessment and QA/QC reporting and interpretation must expand significantly.

A sound system for co-ordinating APIOS activities in all regions should be employed. Regional managers (Air Quality Chiefs)

should be involved in the relevant aspects of field programme planning, and a mechanism should be implemented for incorporating their input into the network operating system. It is recommended that regional air quality chiefs and APIOS Network managers meet on an annual basis to discuss these aspects of the programme.

Recent staff turnovers in the APIOS programme have had significant negative impacts on the operations of the field programmes in the northeastern and southeastern regions. Attempts to replace full-time technologists with part-time consulting personnel were "band aid" solutions to staffing problems that would have been effective in the short-term (i.e. less than one month), but were totally inadequate during long-term periods of eight and seven months at Kingston and Sudbury, respectively. Consulting personnel were asked to collect and process samples and "maintain" site operations in the time allocated (four days per week in the Kingston region and two weeks per month in the Sudbury region). Some problems arising from this situation included:

- poor communication between operators and network personnel which led to inadequate instrument servicing;

- missed changeovers;

- late spring instrument changeover which resulted in a loss of storage gauge data;

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- poor communications between operator and consultants because of time restraints in the field.

Required instrument servicing was performed as quickly as possible to minimize downtime and loss of data, however, complete preventive maintenance was not carried out due to time constraints placed on the consultants. In order to avoid this type of problem in the future, it is recommended that a time limit of one month be put on replacement of network personnel and that network management support this time limit vigourously to help maintain the quality of the network data.

4.3 Evaluation of Routine QA/QC Procedures with Respect to QA Objectives

Routine QA/QC monitoring has now been implemented in many areas of the program and has been evaluated for the cumulative network for the period June 1980 to December 1981 (Bardswick, 1984). In this report information on data recovery, reasons for loss of data, laboratory QA/QC and special studies were reported.

All QA/QC procedures which have been implemented should be reported, and it is essential that these reports be prepared on an annual basis as quickly as possible, in order that the information

contained in them may be used in the annual network review sessions described in the QA Manual (CSC, 1984b).

Since data from the recently implemented routine QA procedures is not yet available, it was not possible in this audit to quantify data quality.

5. RECOMMENDATIONS SUMMARY AND PHASE I AUDIT FOLLOW-UP

This chapter summarizes, in point form, the recommendations made in this report (in the order in which they appear), as well as reviewing the APIOS actions on the recommendations from the Phase I audit. The section in which the recommendations originate is referenced in brackets. Items which may significantly affect data quality have been identified by an asterisk (*) and the QAC should review these immediately and take the appropriate action. Other recommendations should be acted on as soon as possible.

* 1. Corrective action at audited sites (Secton 3.1; Appendix II).

* 2. Review sites with a marginal or poor rating (Section 3.1).

3. Post "Procedural short lists" at monitoring sites (Section 3.1).

4. Inconsistencies in instrument configuration from region to region should be removed (Section 3.1).

5. Service MIC samplers at Dorset (Section 3.2).

* 6. Update network site documentation for the sites in the Central Region (Section 3.2).

7. Regional technologists should continue to maintain close communication with operators, encourage operators to contact them for any reason and try to co-ordinate their site visits so that they can meet with the operators as often as possible (Section 3.2).

* 8. Technologists should carry out procedures audit at least twice a year (Section 3.2).

9. Operators should fill out operator sheets, monthly site summaries and log-books in duplicate, one copy should be retained for future reference and a second copy forwarded to regional technologist (Section 3.2).

* 10. Quality Assurance Activity Log Sheet should be developed and implemented in network operations and procedures (Section 3.2).

* 11. Retraining sessions for technologists should be carried out at the next Quarterly APIOS Technologist meeting (Section 3.2).

* 12. Technologists should ensure that they have on hand at least the recommended instrument spare parts at all times (Section 3.2).

* 13. Instruments in the Central region should be calibrated and serviced on a routine basis (Section 3.2).

* 14. Technologists should visually check field data sheets for omissions and errors (Section 3.3.1).

* 15. Procedures or guidelines followed by the database scientist, used for correcting active values and an "average passive value", should be reviewed and documented and an appropriate code appended to the reported concentration (Section 3.3.1).

16. Procedures or guidelines used in (15) should be included in the Data Management section of the APIOS Technical and Operating Manual (Section 3.3.1).

17. The method of correction for passive filter results should be reviewed (Section 3.3.1).

18. Air concentration data validation procedures should be included in the Data Management section of the APIOS Technical and Operating Manual (Section 3.3.1).

19. QAC should spot check 10% of the operator and field sheets every six months to ensure accuracy and completeness of reported data (Section 3.4).

20. QAC should continue to spot check field sheets and database output (Section 3.4).

21. Result remark code indicating potential or known contamination of a particular filter should be incorporated into the coding system (Section 4.1).

22. The use of the field comment codes H and I should be standardized (Section 4.1).

23. Observations which could affect the integrity of any filters should always be included on the field data sheets (Section 4.1).

24. Symbols used for office comments, fields comments and result remarks should be unique and have precise definitions to avoid ambiguity in interpretation (Section 4.1).

25. The level of confidence in the low level data should be reported to data users in the form of codes attached to specific numbers, outlining measurement method detection

criteria and detection limits and the statistical levels of confidence in numbers (Section 4.1).

26. Regional air quality chiefs and APIOS network managers should meet on an annual basis to discuss these aspects of the program (Section 4.2).

* 27. QA/QC reports should be generated for all data sets and QA/QC information should be included in these data sets (Section 4.3).

Phase 1 Audit Recommendations and the Actions Taken

The following describes the actions taken in response to the 47 recommendations generated from the Phase I audit findings during 1983-84.

#1 Corrective action at audited sites.

action Monitoring sites that required corrective action have been investigated by the QA Coordinator and the environmental tech-

nologist responsible for the site. Where possible, changes have been made to improve the site (i.e. remove a tree, upgrade operator, etc.). A technologist meeting was held in which all corrective actions were discussed and what steps would be taken by the technologists to address the corrective actions recommended by the auditor.

#2 Review of marginal or poor siting by QA Coordinator.

action A review of all sites was undertaken by the QA Coordinator. Using site documentation, photographs, and all of the 1982 data collected at each site, an evaluation of the representativeness or non-representativeness was determined for every site. From this evaluation, the Milton and Attawapiskat monitoring sites were removed from the networks. Colchester and Moonbeam, both rated "poor" by the auditors are still considered representative monitoring sites by APIOS personnel.

#3 Feedback to operators on networks.

action Network operators are kept abreast of monitoring activities by way of a semi-annual newsletter. Also, annual reports of chemical listings for every site are provided to every operator.

#4 Update and upgrade training for operators.

action All technologists have been instructed to thoroughly train every operator in operating procedures. As well, a training video is being prepared for retraining and updating purposes.

#5 Technologists to review APIOS Technical and Operating Manual with operators.

action The review of operating procedures in recommendation #4 includes this review.

#6 Detailed specifications of instrument checks.

action Instrument checks are presently specified for all instruments. The complexity of an instrument determines the amount of detail required for the instrument check. If more time and manpower become available in the programme, detailed instrumentation manuals will be prepared for all instrumentation. However, it is felt that the present instrument checks are more than adequate to ensure the proper operation of the networks.

#7 Sangamo/MIC sensor resistance and clutch setting should be set more often by technologists.

#8 During winter months, snow and ice should be cleaned off the instrument housing of the Sangamo/MIC and Aerochem.

#9 Operators should be instructed by technologists on how to keep on-site log books.

action Technologists have been instructed to carry out these actions.

#10 Incorporate log book recorded information into data screening and validation procedures.

action Any information recorded in the log book that is relevant to a sample is presently entered onto the operator sheet under "Any other factors affecting sample". To attempt to incorporate log books on a routine basis into the data screening process would be very difficult and time consuming. It is felt that if a sample's representativeness is questionable, the log book can be consulted to aid in the validation procedure.

#11 Technologists should review filter handling procedures (especially those that could provide a potential contamination; type of tweezers, washing of filter packs).

#12 Technologists should carry out routine calibration and maintenance of instrumentation.

#13 Technologists should minimize the exposure time of all precipitation samples, event and cumulative, to temperatures above 4°C.

#14 Technologists should alert head office of site changes as described in the Technical and Operating Manual.

#16 Technologists should not park vehicles near samplers. If a vehicle must be brought close to the sampler location, it should never be left running.

action Technologists have been instructed to carry out these actions.

#15 Head office should have an upgrading training session for APIOS technologists.

action As soon as technologist vacancies are filled, an upgrading training session will be held.

#17 Operator Sheets should be compared with Field Sheets periodically by QA Coordinator for errors in data transfer.

#18 Field Sheets should be checked periodically against database for errors in data transfer.

#19 QA Coordinator should periodically verify that technologists are carrying out storage gauge depth determinations correctly.

action These types of checks will be carried out on a routine basis.

#20 Technologists should be made aware of deviations in sampling dates and times at their sites.

action Technologists are aware of these deviations. Technologists have requested operators to follow sampling dates more closely.

#21 Quality of data collected at Gowganda, Moonbeam, Attawapiskat, Ear Falls, and Pickle Lake may be questionable.

action As indicated in the actions responding to recommendation #2, a review of all sites was undertaken. The Milton and Attawapiskat sites, based on the 1982 data, were the only sites removed from the networks due to evidence of local contamination.

#22 To restructure the APIOS Technical and Operating Manual into separate manuals in order to gear for the intended users.

action Presently, the manual is divided into major sections, with each section geared to the intended user. There are no advantages in restructuring the present manual.

#23 Preparation of the QA manual.

action A QA manual has been prepared.

#24 Instrumentation servicing procedures for both operators and technologists should be prepared.

action Operators are not required to service any instruments. If time and manpower becomes available, servicing procedures will be developed, however at present most technologists have sufficient experience and fundamental skills to repair and service monitoring equipment.

#25 The method currently used to fit sample bags should be discontinued and another method adopted.

action The improved method, if followed correctly, will result in a properly placed bag in the collector.

#26 Storage procedures for cumulative precipitation samples for operators and technologists should be developed and included in the operating procedures.

#27 Filter handling blank procedures should be modified to include all potential contamination areas.

action Storage procedures will be prepared. Filter handling blanks have already been modified to include all potential contamination areas.

#28 A schedule detailing which samples and gauges are to be used at different times of the year should be included in the operator procedures.

action During the Spring and Fall, technologists are instructed to set up both types of gauges. Operators are instructed to use whatever gauge is appropriate during these "transition" periods (i.e. use the Nipher gauge for snow events and the rain gauge for rain events).

#29 Consideration should be given to changing the orifice diameter of the various collectors and gauges to reflect an orifice diameter

equal to the diameter of the container measured across the orifice opening from the midpoint of the gauge or bucket wall.

action The knife edge of the M.I.C. collector does not need any consideration. The storage gauge measurement is a depth measurement, not a volume measurement and the knife edge of the Nipher gauge also does not require any consideration. The Aerochem Metric bucket edge is less than 2 mm and is not considered significant.

#30 Modificatons should be made to the M.I.C. collector to improve reliability, operation, and performance and to allow standardization of instrument performance.

action Heaters will be installed inside the collector housing to maintain proper temperatures for P.C. board components and reduce condensation.

#31 Modifications to Aerochem Metrics Sampler.

action This recommendation was made in a previous audit and has already been acted upon.

#32 Modification of the Metrex sequential sampler.

action Flow rate determinations are presently more than adequate (calibrated by mass flowmeters). Installation of mass flowmeters on every sampler is too expensive. Adding time coun-

ters on each channel to ensure clock accuracy is considered over-kill. We are only concerned in ensuring that reported volumes are accurate.

#33 Replace low-volume sampler pump with a more reliable pump.

action The auditor has not demonstrated that the present pump is not reliable. Present pumps last, on average, over 2 years. Considering these pumps are running outdoors 24 hrs/day every day, it is felt that they are reliable.

#34 Replace the storage gauge winter solution with an immersion heater in water. Standardize storage gauge orifice height.

action Storage gauges have been replaced with cumulative Nipher gauges.

#35 Reinforce Nipher shielded gauge support stand.

action Technologists have been instructed to do so where required.

#36 Provide operators with caps for the Nipher shielded gauge collection vessel.

action These have been provided.

#37 All sites should have GFIC's on 115 VAC supply line.

action Technologists have been informed to ensure that all sites have a GFIC circuit (if not - a GFIC receptacle is installed).

#38 On site receptacles should have a cover.

action Technologists have been instructed to install covers at sites where problems have been encountered.

#39 APIOS siting criteria should be added to in the following areas:

- no objects within 5 metres of a sampler;
- sites located in agricultural areas should have a windbreak for 360°;
- windbreaks on site are very desirable especially in the prevailing wind directions;
- due to their effect on airflow, buildings should be located if possible four to five heights away from the sampler;
- on site pollutant sources (e.g., woodburning stoves) should be avoided;
- windbreaks should be located in between roads and the sampler.

action Recommendations by the auditor such as "windbreaks on site are very desirable especially in the prevailing wind direction" are indeed desirable, however if all these were to be incorporated into our criteria, the criteria would be too restrictive. Present criteria are major criteria to be used for the APIOS network.

#40 APIOS should develop a formalized corrective action system.

#41 APIOS should develop a formalized training programme for new APIOS network personnel and also a programme to update and upgrade existing personnel.

action These have been incorporated into the QA manual.

#42 Additional manual data checking should be carried out by technologists and the QA Coordinator as follows:

action Most of these recommendations have been incorporated.

#43 Upper and lower limits of integrity checks for screening cumulative data are determined from historical event data. It should be verified that these limits would not be significantly different if determined from cumulative historical data.

action This verification is to be undertaken in the future. Initially, validated event data was used since no cumulative data was available at that time.

#44 Data should be screened for outliers prior to gross limit checks being carried out.

action The gross limit check is an iterative procedure. The gross limit check is used to identify outliers.

#45 The groupings of sites used for the outliers tests should be checked to see whether any one site repeatedly experiences outliers.

action Intersite correlations are presently under review and information from this evaluation will be used to verify site groupings.

#46 For the outlier test, the log of parameters should be used when applying the Dixon Ratio Test.

action If the distribution of the parameters shows a normal distribution the Dixon ratio test can be used without taking the log.

#47 Consideration should be given to reorganizing the regional technologists' responsibilities to decrease large time allocation that is presently necessary for travel to and from the monitoring sites.

action This recommendation is presently being evaluated because of the "regionalization" of positions which has just taken place.

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APPENDIX I

SITE QUESTIONNAIRES

GUIDELINES FOR THE COMPLETION OF
"MOE SITE DESCRIPTION QUESTIONNAIRE"

PAGE #	SECTION #	NAME	ITEM	GUIDELINES
1	I	Site Identification	1-8	Self-explanatory
1	I		9	Park, government facility, private property, climat site, institution, conservation area
1-2			10-14	Self-explanatory
2			15	Modified Sangamo/MIC, Aerochem Metrics, Nipher, Standard rain gauge, Storage gauge, Low-vol, Metrex sequential, Fisher-Porter Rain gauge Precipitation chemistry, standard precipitation depth, air quality, meteorological
3	II	Site Details	1	Forest clearing, open area, field
3			2	Flat, hill, sloping, bowl
3			3	Self-explanatory
3			4	Grass, grain, soil, sand, moss, rock, gravel
3	II	Site Details	5	Self-explanatory
3			6	Walk, car, 4-wheel drive, snowmobile, snowshoe
3			7	Self-explanatory
3			8	Coniferous trees, deciduous trees, wires, poles, fences, towers. Building height above sampler not above grade
3			9	Distance, direction, general description of area as well as typical heights of snow or amount of dust

PAGE #	SECTION #	NAME	ITEM	GUIDELINES
3				Self-explanatory
4			11	Land use: cultivation, orchard, crops, pasture, forest, water, livestock, garden Ground cover: grass, shrubs, gravel, soil, sand, moss, rock
4			12	Describe any physical changes to site or surrounding area anticipated, i.e., new buildings, new industry, new pollution sources, new roads, new road surfaces, new gardens, new poles or wires, cut trees or exposed earth, etc.
4			13	Locked gate, guard dog, flooding in spring, large snow drifts
4			14-17	Self-explanatory
5	III	Site Influences	1	Self-explanatory
6			2	Access roads, paved roads, unpaved roads, parking lots, garages, major highways within 5 km
6			3	Lakes, rivers, railroads, airports, canals
7			4	Cultivation (specify crop type), orchards, pasture, grazing, trees
7			5	Local: sewage lagoons, salt/sand piles, gardens, gravel pits, marshes, livestock, exposed earth, oil/gas wells, construction activity

PAGE #	SECTION #	NAME	ITEM	GUIDELINES
				Area: Power plants, heavy industry, light industry, open pit mines, foundaries, mines, saw mills, pulp & paper plants within 50 km
8			6	Towns within 5 km, important reference points, major urban centres within 50 km and special notes for large urban/ industrial centres (e.g., Toronto)
8-9			7-9	Self-explanatory
10-11	IV	Site Diagram	1	Use symbols as indicated in legend
12		Topographical Map		Attach a section of the most appropriate topographical map which shows the APIOS site and surrounding area
13		Aerial Photograph		Attach a section of the most appropriate aerial photograph which shows the APIOS site and surrounding area
14		Site Photograph		Include photographs from the four compass points with the sampler in the foreground

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INFORMATION SOURCE DESCRIPTION

FOR: MOE SITE DESCRIPTION QUESTIONNAIRE

SECTION	QUESTION	SOURCE
I SITE IDENTIFICATION	1, 2	Operator/Regional Technician
	3, 4	Auditor
	5	Operator/Regional Technician
	6	MNR/Road or District Map
	7, 8	Topographical Maps
	9	Operator/Auditor's Observations
	10	Operator
	11	Regional Technician
	12	QA Manager/Regional Technician
	13	Operator
	14	Auditor/Operator
	15	Auditor Visual Inspection
II SITE DETAILS	1, 2, 3, 4	Auditor's Observations
	5, 6, 7	Operator
	8	Auditor's Observations
	9, 10	Operator
	11	Aerial Photograph
	12	Operator
	13	Operator/Auditor's Observations
	14	Operator
	15	Operator/Auditor's Observations
	16	Auditor to measure with tape
	17	Operator
III SITE INFLUENCES	1. On Site Observation	Auditor's observation - to be measured with a tape
	1. Local Area Sources	Operator
	2, 3, 4, 5, 6	Operator

INFORMATION SOURCE DESCRIPTION

FOR: MOE SITE DESCRIPTION QUESTIONNAIRE

SECTION	QUESTION	SOURCE
III SITE INFLUENCES (cont'd)	7	Auditor observation and information obtained from topographical map
	8,9	Operator's Observation

MOE SITE DESCRIPTION AUDIT QUESTIONAIRE

I SITE IDENTIFICATION

1. Station Name: _____
2. Station Number (SIS) _____
3. Date of Visit: _____ Time: _____
4. Auditor: _____
5. MOE Region _____
6. County: _____ Townwship: _____
7. Latitude ___° ___' ___" Longitude: ___° ___' ___"
   UTM Co-ordinates _____
8. Elevation _____ m
9. Type of Site (park, gov't facility, private property, etc):
   _____
10. Site Address _____
    _____
    _____
    Mailing Address _____
    (if different _____
    from above) _____
11. Brief description of how to reach site
    _____
    _____
    _____
12. Name of Primary Operator _____
    Alternate Operator _____
    Regional Technician _____
13. Operators Address _____
    _____
    _____
    Mailing Address _____
    (if different _____
    from above) _____
    Telephone Number Home ( ) - _____ Business ( ) - _____
    Alternate Operator Home ( ) - _____ Business ( ) - _____

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MOE SITE DESCRIPTION AUDIT QUESTIONAIRE (Cont'd)

14. Sample Types Collected at Site:

Cumulative Wet_____ Cumulative Dry _____

Event Wet_____ Event Dry_____

Other (describe)_____ Special Study_____

15. List monitoring instrumentation on site.

Instrument Type/Make	Measurement

II SITE DETAILS

1. Physical characteristics of site (i.e. clearing, open area):

_____

2. Site Topography (e.g. flat, hilly, sloping):

_____

3. Ground slope at site: _____

4. Ground cover at site: _____

5. Access to site Summer: Good ____ Fair____ Poor____ N/A____

Winter: Good ____ Fair____ Poor____ N/A____

6. Method of access: Summer: _____

Winter: _____

7. How close do vehicles normally approach sampler?

_____

8. Presence of windbreaks within 100m of sampler:

Type	Height (m)	Distance (m)	Direction
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

9. Where do snow and dust drift and accumulate?:

_____

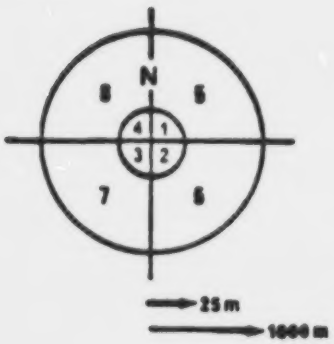
10. Prevailing wind direction during precipitation?:

Winter: _____

Summer: _____

II SITE DETAILS (continued)

11. Land Use:



	Land Use	%	Ground Cover	%
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

12. Future land use, planned or expected (construction, new cultivation, clearing, etc): _____

13. Are there any logistical problems which prevent the sampling site from being easily approached or operated (locked gate, guard dog, flooding in spring, large snow drifts): _____

_____

_____

14. What is the electrical power available at the site?

_____(volts)_____(Amps)_____(# of circuits)

15. Is the circuit on a:

Receptacle GFIC _____No GFIC _____

Circuit Breaker GFIC _____ Battery _____

16. Distance from collector receptacle to circuit panel: _____m

17. What are the number of power failures:

per month_____ per year _____

III SITE INFLUENCES

1. General potential sources of contamination/interferences

Type	HEIGHT(m)/ SIZE	DISTANCE (m)	DIRECTION
<u>On-Site Obstructions</u> Trees			
Poles			
Wires			
Buildings			
Other -			
<u>Local Area Sources</u> (within 5Km) Sewage Lagoons			
Salt/Sand Piles			
Gardens			
Gravel Pits			
Marshes			
Livestock			
Exposed Earth			
Oil/Gas Wells			
Construction			
Human Activity			

III SITE INFLUENCES (continued)

2. Vehicle Related

TYPE	NAME	SURFACE/ USAGE	DISTANCE(m)/ DIRECTION	SNOW/DUST CONTROL
Highways				
Paved Roads				
Unpaved Roads				
Access Roads (Driveways)				
Parking Lots				
Garages				

3. Other Transportation-Related Influences

TYPE	NAME	DISTANCE(km)/ DIRECTION	USAGE	COMMENTS
Lake				
River				
Rail				
Airport				

III SITE INFLUENCES (continued)

4. Agricultural Activities

TYPE	AMOUNT	DISTANCE(km)/ DIRECTION	HERBICIDES/ PESTICIDES

5. Local and Area Pollutions Sources

TYPE	NAME	DISTANCE(km)/ DIRECTION	CAPACITY/ PRODUCT	EMISSION TYPE/RATE

III SITE INFLUENCES (continued)

6. Population Centres

NAME	DISTANCE(km)	DIRECTION	POPULATION

7. Is the site representative of the topography and vegatative ground cover within the surrounding area? (10 - 100 km)

_____

_____

8. List deviations from siting criteria and all advantages and disadvantages of site: _____

_____

_____

_____

_____

_____

III SITE INFLUENCES (continued)

9. Auditor's comments with respect to site (Is it a excellent, good, fair, poor unacceptable site?): _____

_____

_____

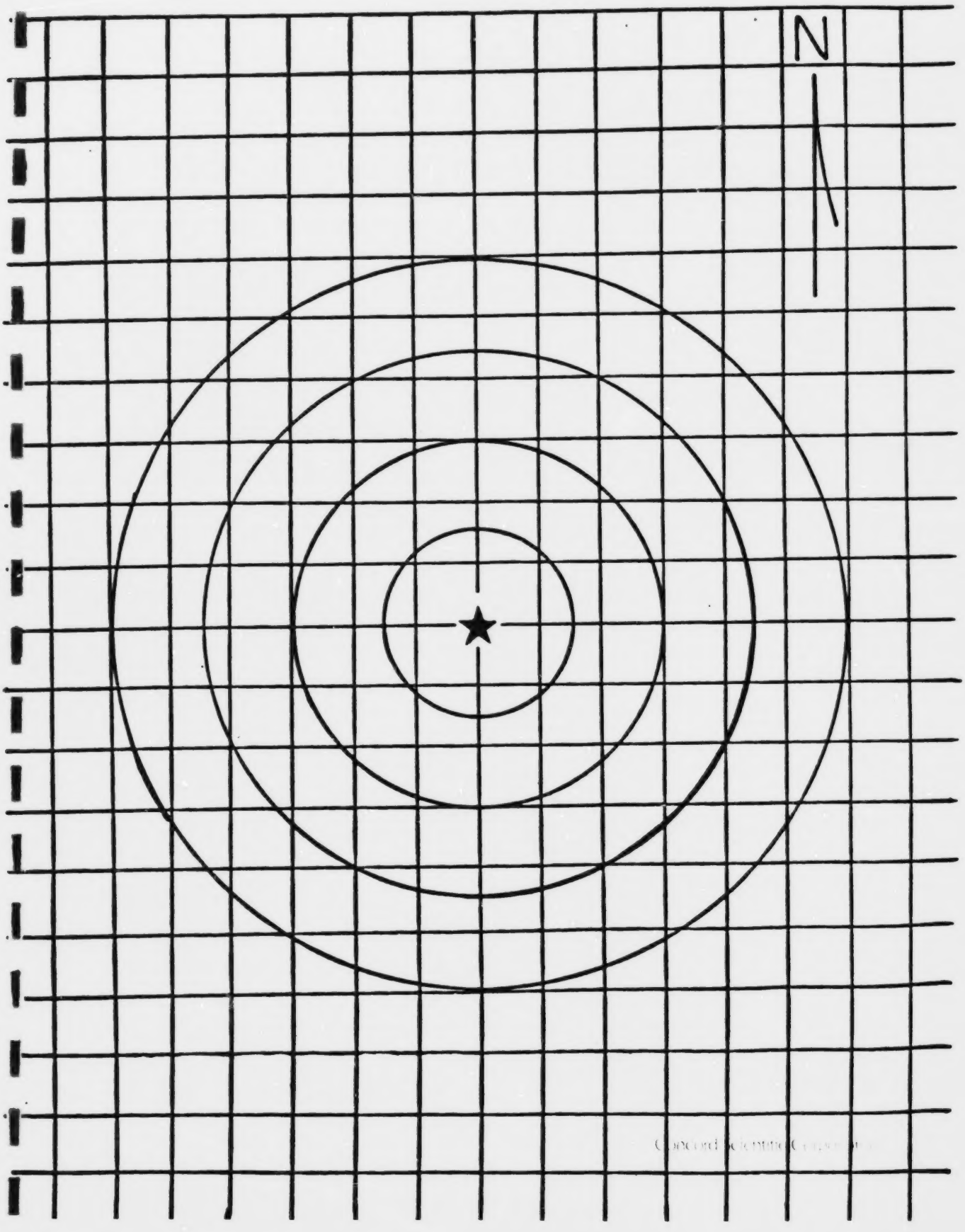
_____

_____

_____

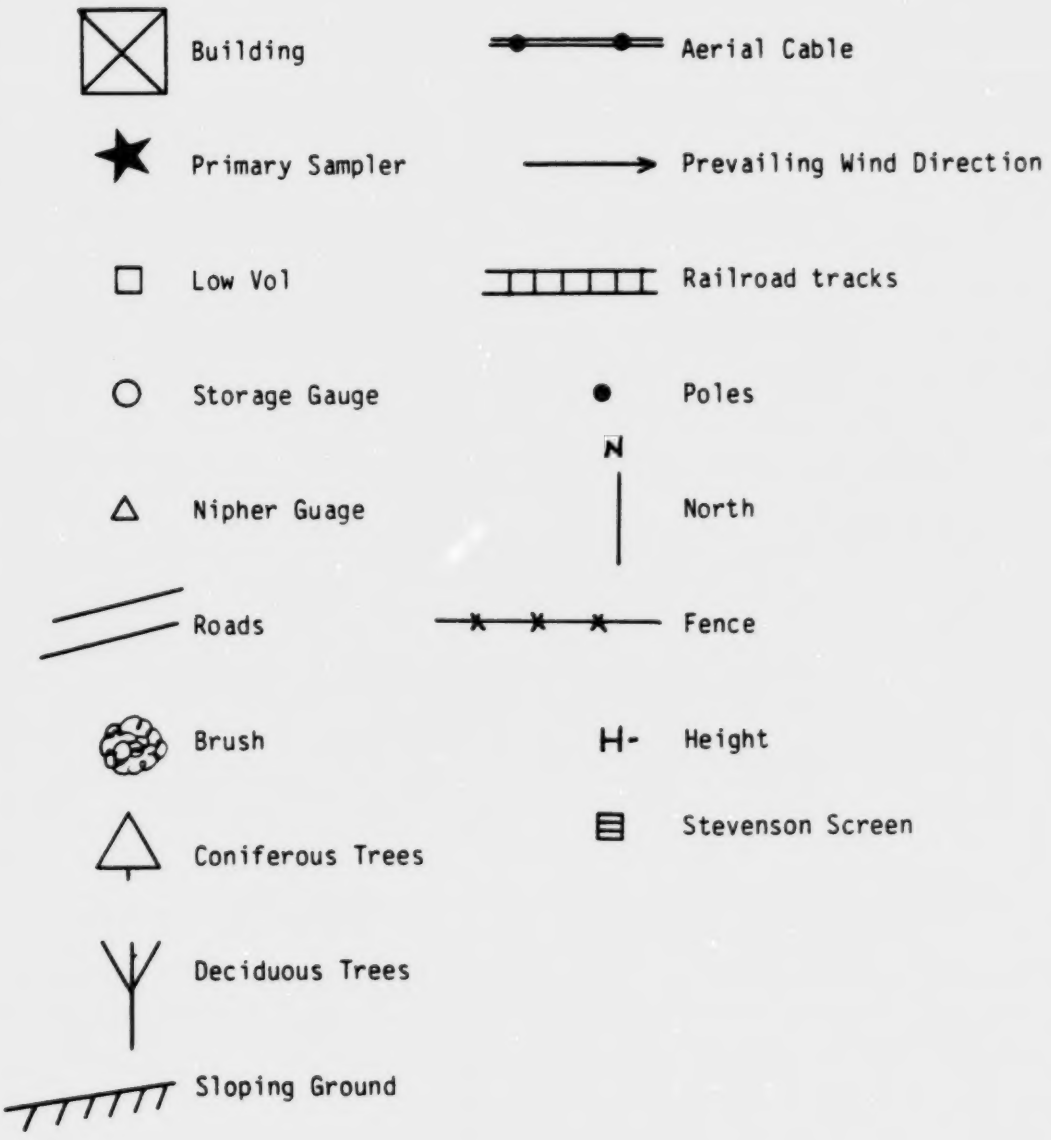
SITE DIAGRAM

Scale



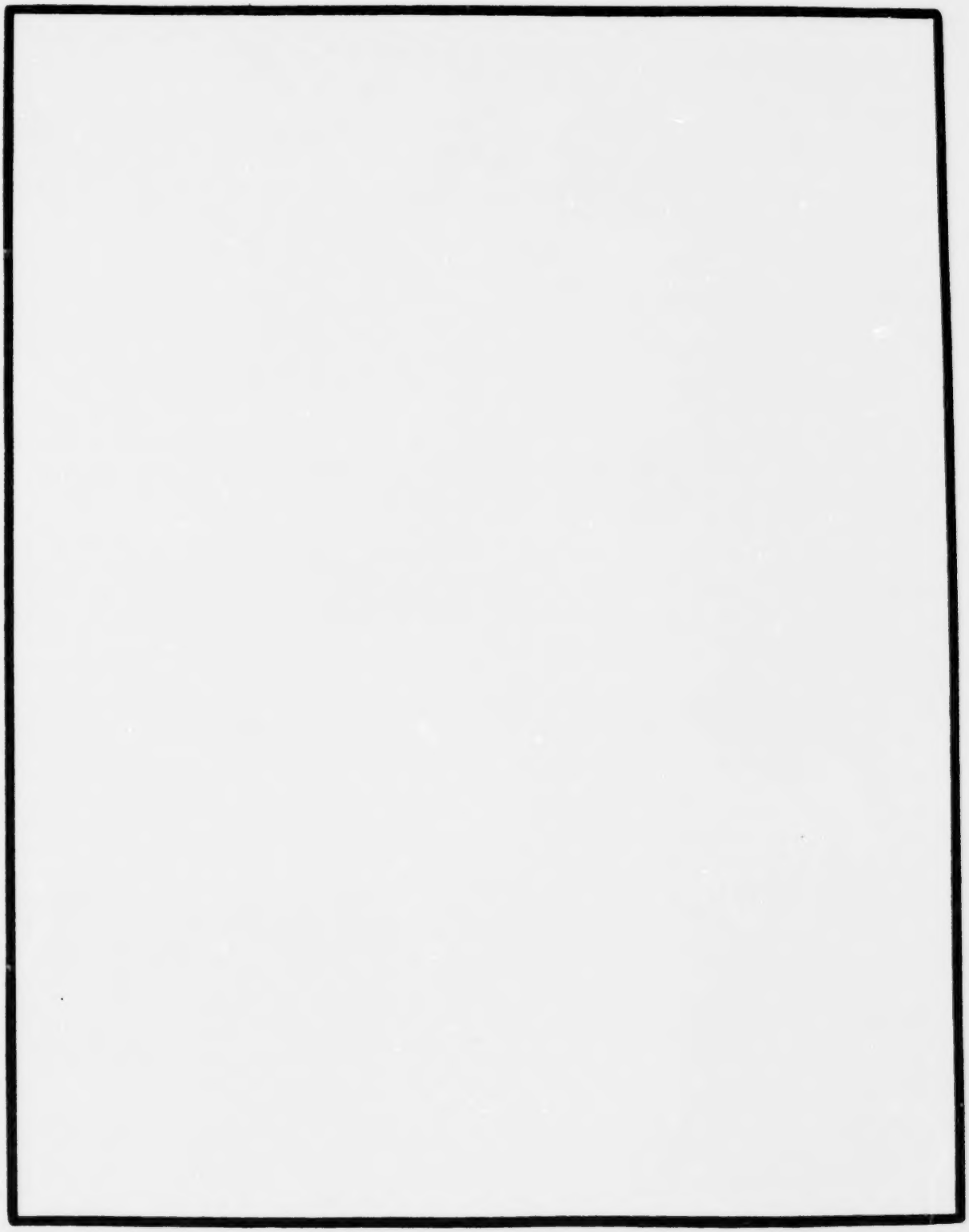
N

LEGEND OF SYMBOLS FOR USE IN SITE DRAWING

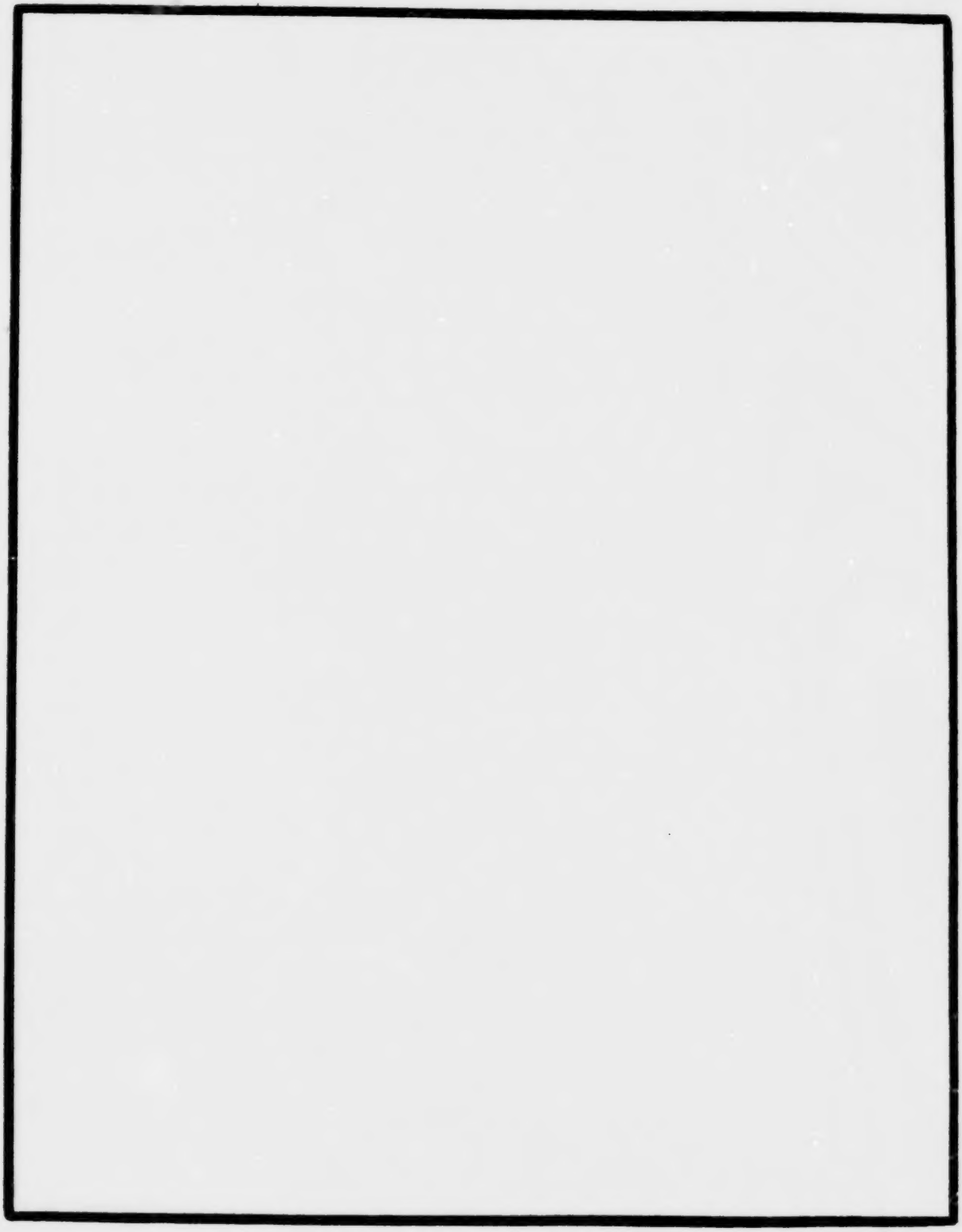


Site Diagram

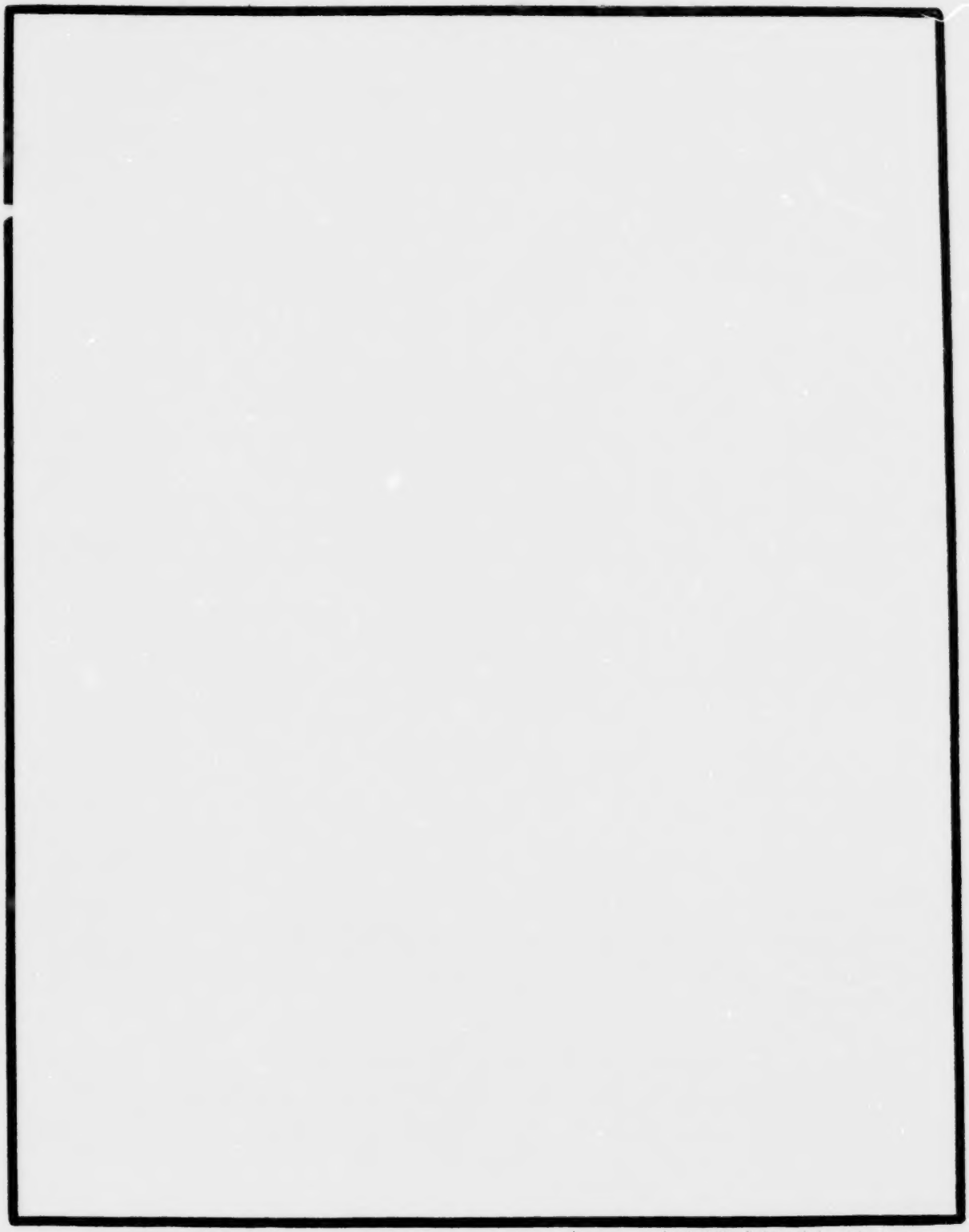
Topographical Map



Site Photographs



Aerial Photograph



TYPE OF MONITORING - CUMULATIVE WET

INSTRUMENT - MIC Collector (Formerly Sangamo Type A - Modified)

Configuration Checks (Record results on "MIC/Sangamo Type A Data Sheets")

1. Ensure gasket on cover contacts knife edge all the way around, especially on farthest position of sampler cover.

2. Ensure sample bag fits container well.

3. Only galvanized support should be used.

4. Original steel U-bolts were to be replaced with stainless steel U-bolts.

5. Knife edge should be level across opening. Qualitatively test by placing clean plastic over open wet bucket with a level on top. Note whether it is level, slightly out of level or not level.

6. Check that the underside of sensor grids is not blackened or discoloured.

7. Check that both grids are warm, not hot to the touch.

Calibration Checks (Record results on "MIC/Sangamo Type A Data Sheets")

1. Instrument Response - Using CSC Ohm Ranger find the resistance of the precipitation sensor necessary to activate the sampler. A resistance of 220 KΩ should cause the sampler to activate. (Figure 1).

2. Heating of Sensor - Measuring the voltage across the two heating terminals on the sensor a pulsing ACV of 5 volts should be detected. If the voltage is not pulsing there is an instrument problem. Test the heater by placing voltmeter probes across heater pins (Figure 2). The grids should feel warm to touch not hot or cold.

3. Clutch Adjustment - Activate and stop sampler midway by turning on and off switch. Place the hook of a spring gauge at the junction of a sampler arm and cover. Holding the other end of the gauge (ring) turn on sampler. The arm should start to move until the gauge reads 14 lbs at which point the instrument clutch should start to slip. Measure the clutch slip. (Figure 3).

4. Limit Switch Adjustment - Activate sampler and when sampler cover reaches midway turn off sampler and unplug from receptacle. Remove instrument screen and cover.
   a) Depress limit switch plungers (2x) until they click and then release. Switch plungers should spring back without sticking.
   b) Visually inspect switch plungers. Note any deformity of plunger.

   Plug sampler back into receptacle and turn sampler on observing angle of adjustment screw and limit switch plunger.
   c) Note if adjustment screw is contacting plunger on such an angle as to damage switch.
   d) Note if adjustment screw at end of travel is bending limit switch support bucket. (Figure 4).

5. Gasket Seal on Knife Edge - Place a thin layer of clear compressable foam on the edge and allow sampler cover to move and compress foam will allow a check of gasket sealing ability. After a short interval activate sampler and inspect knife edge impression on foam. (Figure 5).

6. Sampler Delay Time - Short sensor with metal strip or moistened finger and start stopwatch. Stop stopwatch when sample cover starts to return to wet side of instrument.

FIGURE 1

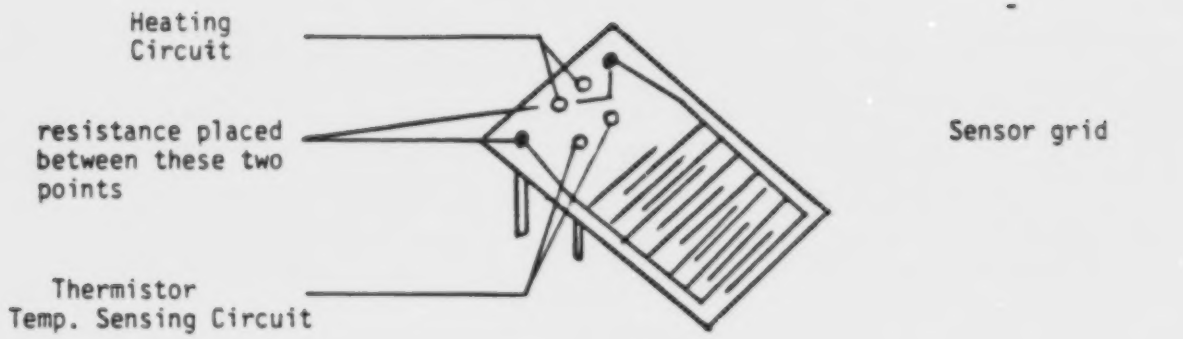


FIGURE 2

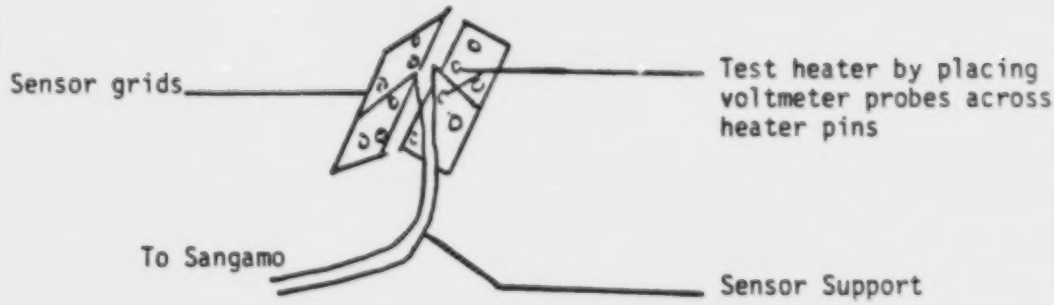


FIGURE 3

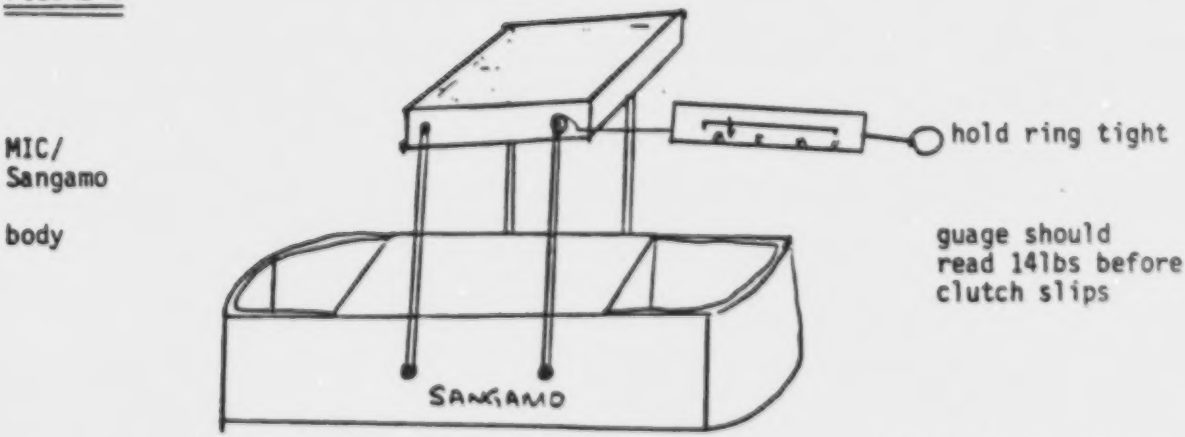
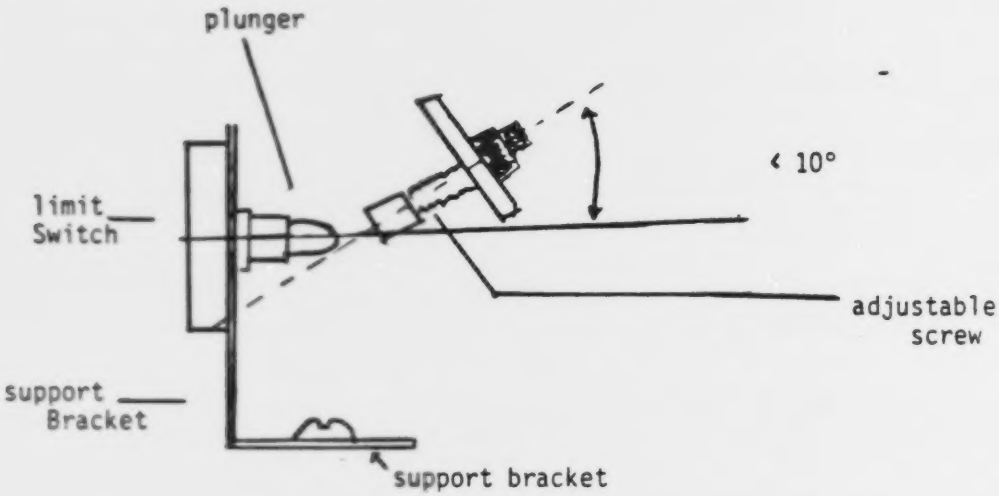
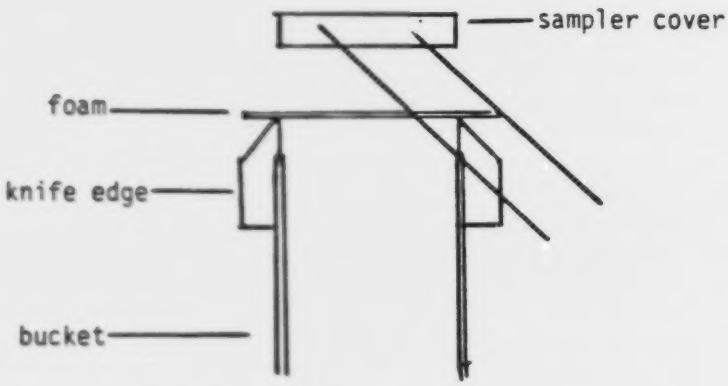


FIGURE 4


plunger
limit
Switch
< 10°
adjustable
screw
support
Bracket
support bracket


sampler cover
foam
knife edge
bucket

MIC/MODIFIED SANGAMO TYPE A DATA SHEET

Site: _____

Serial #: _____ Model #: _____

On Stand? _____ Height above ground _____

	N - S	E - W
	WET	WET
(Bucket) SAMPLE ORIFICE (cm)		
(Bag) SAMPLE ORIFICE (cm)		

Level _____

Precipitation Sensor Checks

Knife edge gap _____ mm Delay Time _____ sec

Instrument Response _____ kΩ Clutch Adjustment _____ lbs

Heating of Sensor _____ volts pulsing? _____

Warm to touch _____ Blackened/Discolored? _____

Comment on:

Limit Switch Adjustment: _____

_____

_____

Gasket Seal on Knife Edge: _____

_____

_____

Hood Movement: _____

_____

_____

Bag Fit: _____

_____

_____

CUMULATIVE PRECIPITATION AUDIT - SANGAMO/MIC

OPERATOR: _____

SITE: _____

Operator's Duties	Yes	No
1. What time does operator change sample bags? If he can't change at the proper time, what does he do? (phone technican, change bag when he can, contact alternate operator). _____ _____ _____		
2. Does the operator, while removing the sample bag from the sample bucket, allow for any chance of contamination of the precipitation sample? Several points that may present contamination are:		
- is sample bucket removed from sampler prior to changing sample bag?		
- does the operator wear clean, new gloves to remove the knife edge?	___	___
- does he handle only the outside of bucket and knife edge?	___	___
- is he careful not to contaminate knife edge when its taken off?	___	___
- is bag removed in such a way as to not introduce contamination from top and outside portions of bag?	___	___
- is operator careful not to stand directly over pail?	___	___
- is there a potential for contamination by hair, coat, etc.?	___	___
Comments: _____ _____ _____ _____		

CUMULATIVE PRECIPITATION AUDIT - SANGAMO/MIC (continued)

Operator's Duties	Yes	No
3. Are the sample bags properly handled to prevent damage, sample loss and allow for proper handling by laboratory staff? Several points should be checked:		
- is air forced out of bag before sealing?	___	___
- is bag tied near enough to the top so that it can be leached for metals analysis, but far enough down so that none of the contaminated surfaces are exposed to sample? How is bag tied and sealed? _____	___	___
_____		
- does operator use a container to store and transport sample? _____	___	___
- are bags promptly labelled (What information is recorded on label)? _____	___	___
_____		
- for winter operation with long tube how is bag removed? _____		
_____		
- where does operator store sample for pick up by technician? (winter and summer). _____		
_____		
- how long does it take the technician to come and pick up samples? _____		
_____		
Comments: _____		
_____		
_____		
_____		

CUMULATIVE PRECIPITATION AUDIT - SANGAMO/MIC (continued)

Operator's Duties	Yes	No
4. Are the sampler components carefully cleaned? Several points to be checked:		
- does operator clean the following before putting in new bag:		
Sensor grids with H_2O and ETOH?	___	___
Hood gasket with H_2O and ETOH?	___	___
- does he use new gloves and Kimwipes for above? _____		
- what is the cleaning procedure under cold conditions? _____ _____		
Comments: _____ _____ _____ _____		
5. What problems does the operator experience with the sampler? How does he handle them? Some things that can happen:		
- does wet sample bag get stuck in container when being removed? _____ _____	___	___
- what does operator do if this happens? _____ _____ _____		
- what procedure is followed if the bag comes out damaged? _____ _____ _____		

CUMULATIVE PRECIPITATION AUDIT - SANGAMO/MIC (continued)

Operator's Duties	Yes	No
- how often are leaks observed in bags? _____		
_____		
- what does he think causes it? _____		
_____		
Comments: _____		
_____		
_____		
_____		
6. In placing a new sample bag in the collector, does the operator observe the following points:		
- are new gloves worn when touching inside of bag?	___	___
- is operator careful not to touch inside of bag any more than is necessary?	___	___
- is bag forced to bottom of container by filling with air? _____	___	___
_____		
- is operator careful not to put hand inside bag when installing it?	___	___
- is enough bag left over the edge to permit knife edge to hold bag?	___	___
- are new gloves used to flatten bag against the pail?	___	___
- is collar cleaned, rinsed and dried before replacing on container?	___	___

CUMULATIVE PRECIPITATION AUDIT - SANGAMO/MIC (continued)

Operator's Duties	Yes	No
- Does the end result produce a well fitting bag? (smooth surface, no overhang). _____		
Comments: _____		
7. Does the operator have a good knowledge of what he is expected to do? Specific points that the operator should be asked:		
- does operator have written instructions for procedures?		
- which procedures does he have? _____	—	—
- does he think he was adequately trained? _____	—	—
- when was the last time the regional technician reviewed procedures with him? _____		
- does he have any particular problems with the sampling? _____	—	—

CUMULATIVE PRECIPITATION AUDIT - SANGAMO/MIC (continued)

Operator's Duties	Yes	No
Comments: _____		
_____		
_____		
_____		
8. Does the operator have sufficient supplies on site? He should be asked:		
- does he receive regular shipment of supplies or as needed? _____		
_____		
- does he have enough of the following:		
sample forms?	___	___
bags?	___	___
DIH_2O and ethanol?	___	___
kimwipes?	___	___
gloves?	___	___
- has he ever run out of supplies?	___	___
Comments: _____		
_____		
_____		
_____		
9. What comments does the operator have about the programme?		
- does the operator understand why he is collecting the samples? _____	___	___
_____		

CUMULATIVE PRECIPITATION AUDIT - SANGAMO/MIC (continued)

Operator's Duties	Yes	No
- does operator understand why all the special precautions (glove, cleaning bags etc.) are required? _____ _____		
- does operator get any feedback on programme?	___	___
- Would he like feedback? How often? _____ _____	___	___
- does he have any special comments with regards to the sampling, site, technician or programme as a whole? _____ _____		
- does he feel the pay is adequate?	___	___
Comments: _____ _____ _____ _____		
10. Does the operator check sampler performance on a regular basis?	___	___
- does he check that hood seals tightly	___	___
- does he check that the sensor grid is warm?	___	___
- what other instrument checks does he perform periodically? _____ _____ _____		
- how often does he check the instrument? _____ _____		

CUMULATIVE PRECIPITATION AUDIT - SANGAMO/MIC (continued)

Operator's Duties	Yes	No
Comments: _____		
11. Does the operator maintain a site log book?	___	___
- what type of information is recorded _____		
- how often is information recorded? _____		
Comments: _____		
12. Are sample submission sheets correctly and completely filled out? _____	___	___
13. Does the Regional Technician visit the site?	___	___
- how often? _____		
- does he talk to the operator on each visit, or is the sample just left at a location for pickup? _____	___	___

CUMULATIVE PRECIPITATION AUDIT - SANGAMO/MIC (continued)

Operator's Duties	Yes	No
- do the technician and operator discuss sample problems?	___	___
- other than talk to the operator what else does the technician do on his site visits?_____		
_____		
_____		
Comments: _____		
_____		
_____		
_____		

TYPE OF MONITORING - CUMULATIVE WET

INSTRUMENT - STORAGE GAUGE

Configuration Checks (Record results on "Storage Gauge Data Sheet")

1. Storage gauge opening should be level. Qualitatively test by placing level across opening. Note whether it is level, slightly out of level or not level.

2. Measure the height of the bottom of the storage gauge from the ground.

3. Measure the height of the orifice of the storage gauge from the ground.

4. Visually note any floating debris in guage or adhered to inside gauge walls. Using metre stick check for any sunken debris.

Calibration Checks (Record results on "Storage Gauge Data Sheet")

1. Gauge Opening - Measure inside opening of storage gauge with a ruler. Repeat at 90° from first reading.

2. Solution and Capping Layer - Visually note whether solution is methanol/ethylene glycol (slight alcohol - like odor) or water (no odor).

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STORAGE GAUGE DATA SHEET

Site: _____

Serial #: _____ Model #: _____

On Stand? _____ Storage Gauge Height above ground _____
Orifice Height above ground _____

How is the base of storage gauge supported? _____ _____
_____

Sample Orifice (cm) N-S _____ level N-S _____
E-W _____ E-W _____

Solution Type: Methanol Ethylene Glycol _____ _____
Water _____

CUMULATIVE PRECIPITATION AUDIT - STORAGE GAUGE

OPERATOR: _____

SITE: _____

Operator's Duties	Yes	No
1. Does operator take a storage gauge measurement? ____		
_____	___	___
2. How does the operator take the depth measurement?		
_____		
_____		
3. Does the operator have a thermometer present for winter time measurements? _____	___	___
_____		

Comments: _____

_____

_____

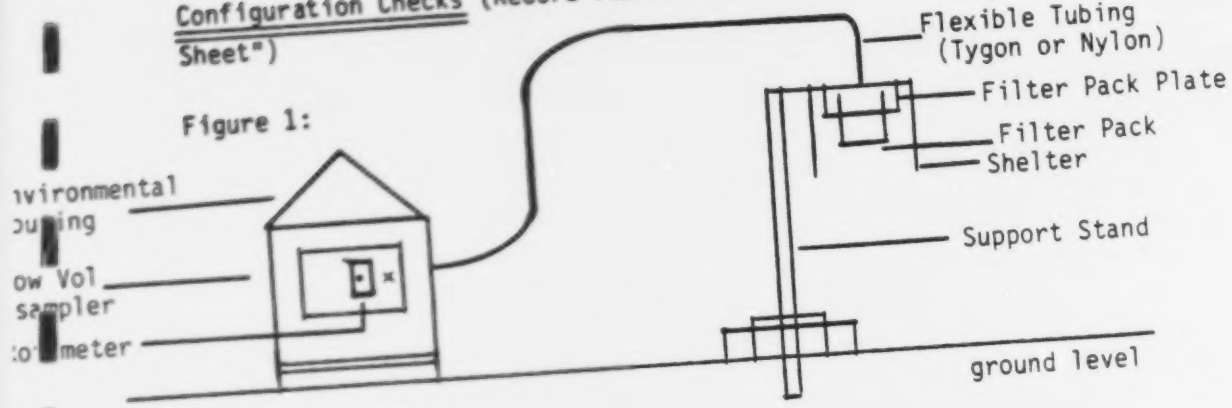
_____

TYPE OF MONITOIRNG - CUMULATIVE DRY

INSTRUMENT - METREX LOW-VOL SAMPLER

Configuration Checks (Record results on "Low-Vol Sampler Data Sheet")

Figure 1:



1. Note any deviations of the sampling configuration, (see Figure 1).

2. Observe flow rotameter. Is there a black ring on walls of rotameter? If yes describe ring thickness, colour (dark black, grey, brown).

3. The filter pack should be level. Qualitatively check by placing level across filter pack case. Note whether it is level, slightly out of level or not level.

Calibration Checks

1. Flow - Calibration of Rotameter: Turn off Lo-Vol Sampler and disconnect suction line from the back of the sampler. Place a 0-5 l/min mass flowmeter in line. Turn sampler and mass flowmeter on and allow 20 minutes for warm-up. Check for leaks in system. The output of the mass flow-meter should be connected to a digital voltmeter(scale 0-5 VDC). Use the flow control adjust on the sampler to perform a multi-point (10 values) calibration allowing 30 seconds per reading to allow the flow rate to stabilize (record results on "Rotameter Calibration Table"). The calibration should cover a range of 0-5 l/min.

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2. Volume - Calibration of Volumetric Counter (Gas meter) The instrument set up for calibration is the same as in the "Calibration of Rotometer" except that once the flow controller has been set to approx. 2 l/min it should not be adjusted. When unit on volumetric counter changes start stop watch and record volumetric counter reading and mass flowmeter reading. Each time the volumetric counter changes (approximately 5 minutes) record volumetric counter reading, mass flowmeter reading in VDC, Low-Vol rotameter reading, and time (record results in "Volume Counter Calibration Table").

METREX LOW-VOL SAMPLER DATA SHEET

Site: _____

Serial #: _____ Model #: _____

On Stand? _____ Height above ground _____

Sample Orifice (cm) N-S _____ level N-S _____
E-W _____ E-W _____

Sampling line and tower in good condition? _____

Kinks in suction line? _____

Tower firmly supported, straight and steady? _____

Low-Vol sampler - covered? _____
_____

- located so as not to be influenced by other nearby samplers or objects? _____
_____

Rotameter Condition - grey, brown or black ring? _____

Rotameter Calibration Temperature _____

Reading #	Low-Vol Rotameter Reading l/min	Voltmeter Reading (VDC)	Mass Flowmeter Reading (l/min)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Volume Counter Calibration Temperature _____

Reading #	Time (min & sec.)	Volume Reading (1 x 10)	Voltmeter Reading (VDC)	Mass Flowmeter Reading (l/min)	Low-Vol Rotometer Reading (l/min)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

CUMULATIVE DRY DEPOSITION - LOW VOL

OPERATOR: _____

SITE: _____

Operator's Duties	Yes	No
1. Describe the procedure used by the operator in handling filter packs. Does he do the following?		
- handle filter packs only by using a plastic bag or on the filter pack? _____	___	___
- where are the filter packs stored? _____		
Comments: _____		
2. What information is recorded on data sheets?		
- flow rate - start and finish?	___	___
- volumetric reading?	___	___
- time of filter pack changeover?	___	___
- operator comments?	___	___
Comments: _____		
3. What training did operator receive on the sampler		
- handling filter packs? _____	___	___
- has he been retrained since?	___	___
- does he feel training was adequate?		
Comments: _____		

EVENT DRY DEPOSITION - SEQUENTIAL SAMPLER

OPERATOR: _____

SITE: _____

Technician/Operator's Duties	Yes	No
1. Describe operators procedures prior to lowering the boom? Does he do the following?		
- field sheet prepared for each filter pack or tower?	___	___
- are sampling channel flows transferred to data sheet?	___	___
- is the time showing on mechanical clock correct?	___	___
- is the flow rate checked?	___	___
_ is the sampler turned off before the boom is lowered?	___	___
Comments: _____		
2. After the boom has been lowered, describe the procedure used to reload filter pack. Is the following done:		
- is a new clean sample bag used to remove filter pack?	___	___
- what type of bag is used? _____		
- are either the filter packs or bags labelled corresponding to sample channel? If not how are the filter packs identified? _____	___	___
- is the filter pack sampling for that day transferred to another sampling channel? What channel? _____	___	___

EVENT DRY DEPOSITION - SEQUENTIAL SAMPLER (CONT'D)

Technician/Operator's Duties	Yes	No
- is the sampler turned off while filter packs are being removed?	___	___
Comments: _____		
3. Describe procedure used to reload filter packs. Is the following done:		
- is the filter pack installed on tower while still in bag or is it removed by hand and then installed? _____		
- when are the sampling channels zeroed? _____		
- is the sampler restarted when the boom is on the ground or after being raised? _____		
- does the technician cycle through all channels after sampler is restarted? _____	___	___
4. What information is recorded on the sample sheets and in the site log book? _____		
5. How frequently is the sampler checked, daily, weekly? Who does the checking the technician or someone else? _____		

EVENT DRY DEPOSITION - SEQUENTIAL SAMPLER (CONT'D)

Technician/Operator's Duties	Yes	No
6. At the laboratory how long do the filter packs usually sit before being unloaded?_____		
_____		
7. Does the technician unload filter packs in a:		
- laminar flow chamber?		
- fume hood?	___	___
- office?	___	___
- laboratory?	___	___
	___	___
8. Are there any exposed contaminants in filter processing area?		
- anyone smoking nearby?_____		
- any exposed chemicals - especially H_2SO_4 or HNO_3	___	___
_____	___	___
- is the area generally clean or dirty?_____		
Comments: _____	___	___
_____		
_____		
9. What kind of work surface does the technician use?		
- teflon coated table top?		
- lab bench?		
- lab bench with plastic on top?	___	___
- office desk?	___	___
Comments: _____	___	___
_____		
_____		

EVENT DRY DEPOSITION - SEQUENTIAL SAMPLER (CONT'D)

Technican/Operator's Duties	Yes	No
10. Is the technician's system for labelling bags easily understandable and logical? (describe the system used)	___	___
- is it done all at once prior to unloading any filter pack?_____	___	___
- is it done as filter packs are unloaded?_____	___	___
_____		
Comments: _____		
_____		
_____		
11. Describe the procedure used for handling the filters? Are the following points observed?		
- are teflon tweezers used for filter handling?	___	___
- are tweezers stored in methanol prior to use?	___	___
- are they wiped with new Kimwipe before touching filters?	___	___
- are separate tweezers used for impregnated and unimpregnated filters?	___	___
- are Nylon and Impregnated W41 filters folded twice before placement in sample bags?	___	___
- are gloves worn during filter pack unloading?	___	___
Comments: _____		
_____		
_____		
12. Describe the procedure used for the washing and drying of filters? Is the following done:		
- where are filter samples stored after unloading from filter packs?_____		
_____		

EVENT DRY DEPOSITION - SEQUENTIAL SAMPLER (CONT'D)

Technican/Operator's Duties	Yes	No
- are filter packs completely disassembled prior to washing?	___	___
- are the filter packs rinsed after washing? What rinses are used?_____	___	___
- how many of each type of rinse are performed?___		
- how are the filter packs dried? If air dried, are they covered during drying? What covering is used?_____		
- if dried in an oven, how long, what oven temperature?_____		
- are the filter packs used after drying? If not, how are they stored?_____	___	___

Comments: _____

13. Describe the procedure used for reloading of filter packs. Is the following done:

- does the technician clean off the area where filter packs will be loaded?	___	___

EVENT DRY DEPOSITION - SEQUENTIAL SAMPLER (CONT'D)

Technican/Operator's Duties	Yes	No
- is the work surface a lab bench, Teflon overlay board, "Kimwipes" over lab bench or other area? _____		
- are cleaned tweezers kept in separate breakers - one for unimpregnated and one for impregnated filters?	___	___
- when removing filters from bag does technician push his hand into bag or only tweezers? _____ _____		
- when placing collar on filter pack is technician careful not to get hand near open exposed face of filter?	___	___
- is the inlet of the filter pack checked to ensure the O-ring has not failed?	___	___
- is the loaded filter pack numbered and stored in a new "Zip-lock" or "Whirl-pak" bag? _____ _____	___	___
- how are loaded and bagged filter packs stored prior to shipment to field? _____ _____ _____		
Comments: _____ _____ _____		
14. Are any of the filters from Toronto ever damaged? (i.e. nicks out of the sides). If so what is done with them? _____ _____ _____	___	___

TYPE OF MONITORING - EVENT WET

INSTRUMENT - AEROCHEM METRIC

Configuration Checks (Record results on "Aerochem Metric Data Sheet")

1. The Aerochem Metric has a reputation for being blown over in winds. The sampler should be securily mounted by either stakes, wire or cross pieces. Insure that the sampler can not be pushed over. (Figure 1).

2. The instrument should be level. Qualitatively check by placing clean plastic over the bucket with a level on top. Note whether it is level, slightly out of level or not level.

3. Check cleanliness of a) gasket, b) sensor, c) sensor body.

Calibration Checks (Record results on "Aerochem Metric Data Sheet")

1. Heating of Sensor - When sampler is not activated sensor should be cold to touch. When activated, the sensor should get hot after approximately 5 minute delay, and stay hot until activating precipitation evaporates.

2. Cover Seal Integrity - A thorough visual inspection of cover checking for: a) holes in polyethylene gasket cover;
   b) signs of gasket foam crumbling;
   c) moisture on inside surface of polyethylene.

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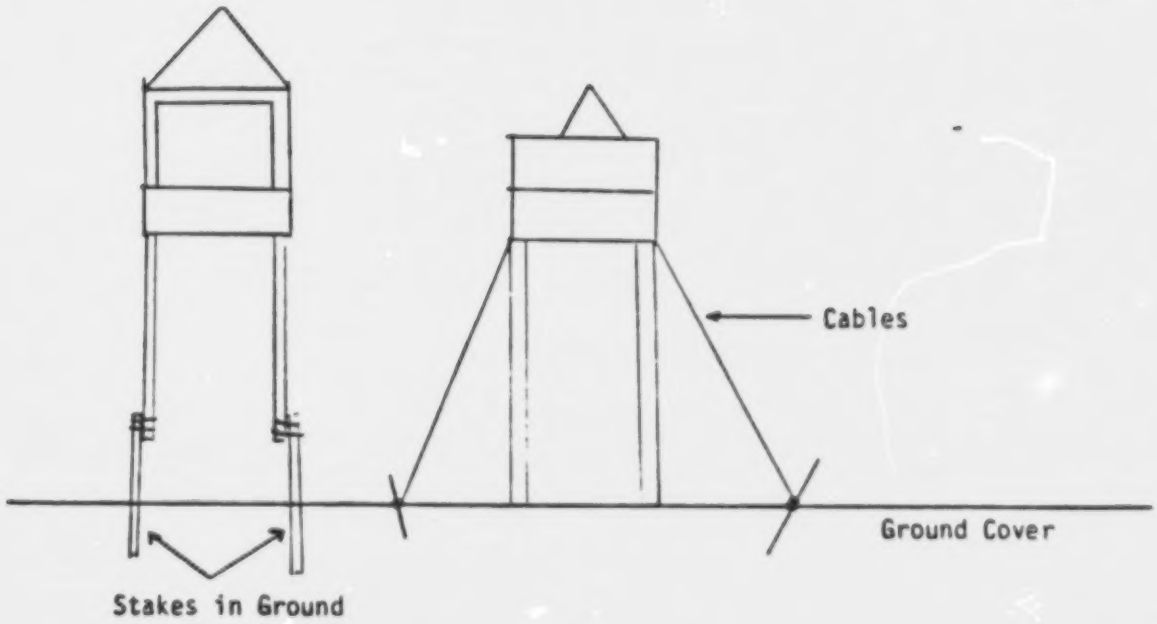
FIGURE 1



AEROCHEM METRIC DATA SHEET

Site: _____

Serial #: _____ Model #: _____

Sample Orifice (m) N-S _____ level N-S _____
E-W _____ E-W _____

Secured by: stakes _____ sturdy? _____
wire _____
cross pieces _____

	Yes	No
Cleanliness - Gasket		
- Sensor		
- Sensor Body		
Any holes in gasket cover?		
Is gasket foam crumbling?		
Any moisture on inside surface of cover		
Sensor heating properly?		

Comments: _____
_____
_____
_____

EVENT PRECIPITATION AUDIT - AEROCHEM METRIC

OPERATOR: _____

SITE: _____

Operator's Duties	Yes	No
1. What time does the operator check the sample bag for precipitation? If he cannot change at the proper time, what does he do? (phone technician, change bag when he can, contact alternate operator). _____ _____ _____ _____		
2. Does the operator, while removing the sample bag from the sample bucket, allow for any chance of contamination of the precipitation sample? Several points that could lead to contamination are:		
- is the sample bucket removed from the sampler prior to changing sample bag?	___	___
- does the operator wear clean (new) plastic gloves to handle the bag?	___	___
- is the outside of the bag folded up allowing contamination to enter bucket?	___	___
- is the operator careful to not stand directly over sample bucket while removing sample bag? Is there potential for contamination from operator's hair, clothes etc.?	___	___

Comments: _____ _____ _____ _____

EVENT PRECIPITATION AUDIT - AEROCHEM METRIC (continued)

Operator's Duties	Yes	No
3. After the bag is removed from the sample container,		
- is air evacuated from the bag after being removed from container?	___	___
- is the top of the sample bag tied?	___	___
- how far from the top of bag is it tied?	___	___
- what is the sample bag tied with?	___	___
- any chance for othe contamination (clothing, etc)?	___	___
Comments: _____		
_____		
_____		
4. For reloading the sample bucket:		
- in placing new bag in sample container, does operator wear gloves?	___	___
- does the operator touch the inside of bag when loading into sample container with only new, clean gloves?	___	___
- any chance for other contamination (clothing, etc.)?	___	___
Comments: _____		
_____		
_____		
5. When the new bag is loaded in the sample bucket:		
- does the bag fit the container well? _____	___	___
- how much of a decrease in orifice size results from poor bag fit? How much is the sample area reduced (%)? _____		
Comments: _____		
_____		
_____		

EVENT PRECIPITATION AUDIT - AEROCHEM METRIC (continued)

Operator's Duties	Yes	No
6. Describe how the operator transfers the precipitation sample from the sample bag to the sample bottle?		
- does the operator inspect sample bottle for flaws?	___	___
- does he swirl bag and contents around prior to decanting?	___	___
- how is sample melted if partially or completely frozen? _____ _____		
- does operator pour sample directly from bag into sample bottle?	___	___
- does he use a clean funnel?	___	___
- does he elevate one bottom corner, clean, and cut it?	___	___
- describe cleaning procedure of bag and scissors? _____ _____ _____		
- if sample volume exceeds bottle contents, is excess poured into graduate and measured?	___	___
- where is the sample transfer area? _____ _____		
- is a clean sample preperation area used?	___	___
Comments: _____ _____ _____		

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EVENT PRECIPITATION AUDIT - AEROCHEM METRIC (continued)

Operator's Duties	Yes	No
7. Sample bottles should be labelled to correspond with date submission sheets: - what information is placed on sample label? _____ _____ - is label placed on cap or bottle? _____ _____ - where are samples stored for pickup by technician? _____ _____ - how long are samples usually stored prior to pick-up by technician? _____ _____		
Comments: _____ _____ _____		
8. What information is entered on the data sheets? - is any information not filled out or incorrectly filled out? _____ _____ _____	___	___
9. Is there a log book on site? - what information is recorded? _____ _____ - how often is information entered into log book? _____ _____	___	___

EVENT PRECIPITATION AUDIT - AEROCHEM METRIC (continued)

Operator's Duties	Yes	No
10. When was the last time technician reviewed sampling procedures with operator? _____		
- how often are procedures reviewed? _____		
_____		
- does the operator think procedures should be reviewed more often? _____	___	___
- does he think he was adequately trained	___	___
- does he have any particular problems with the sampling	___	___
Comments: _____		
_____		
11. Does the operator have sufficient supplies to last for one week, one month, six months? Has the operator ever run out of supplies? _____	___	___
_____		
_____		
12. What comments does the operator have about the programme?		
- does the operator undertand why he is collecting the sample? _____	___	___
_____		
- does he understand why all the special precautions (gloves, cleaning, etc.) are required?	___	___
- does operator get any feedback on programme? Would he like some? How often? _____	___	___
_____		
- does he feel the pay is adequate?	___	___

TYPE OF MONITORING - EVENT WET

INSTRUMENT - STANDARD RAIN GAUGE

CONFIGURATION CHECKS
(Record results on "Standard Rain Gauge" Data Sheet)

1. Measure from collector rim to ground.

2. Measure from top of grass to collector rim.

3. Inspect funnel and graduate for cracks and cleanliness.

4. Determine height of and distance to nearest obstruction, including sampler.

5. Insure that gauge is emptied each morning.

6. The instrument should be level. Qualitative check by placing level over gauge orifice. Note whether it is level, slightly out of level or not level.

7. Pour pre-measured 50 ml aliquot into gauge and record reading.

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STANDARD RAIN GAUGE DATA SHEET

Site: _____

Serial # _____ Model # _____

Collector rim to ground _____

Collector rim to grass _____

		Cracked	Clean
Graduate	(Yes, No)	_____	_____
Funnel	(Yes, No)	_____	_____

Obstruction	Height of Obstruction (m)	Distance from Gauge (m)

Gauge Level _____

Gauge Reading _____ (mm)

EVENT PRECIPITATION - STANDARD RAIN GAUGE

OPERATOR: _____

SITE: _____

Operator's Duties	Yes	No
1. Is the standard gauge checked each day?	___	___
2. How does the operator handle the following situation:		
- if water level (meniscus) falls between two graduated marks? _____		
- what is recorded if level is below 0.2 on scale? _____		
- if there is water that has overflowed the graduated cylinder, what does the operator do? _____		
- what is done for freezing rain? _____	___	___

APPENDIX II

SITE AUDIT SUMMARIES

TABLE 3.1

Sites Visited During the Phase II Site Audits

Site	Type
Merlin	Cumulative Wet
Port Stanley	Cumulative Wet & Dry
Pickle Lake	Cumulative Wet & Dry
Forbes Township	Event Wet
Quetico Centre	Cumulative Wet and Event Wet
Ear Falls	Cumulative Wet & Dry
Experimental Lakes Area	Cumulative Wet
Dorset	Cumulative Wet & Dry, Event Wet & Dry
Whitney	Cumulative Wet
Coldwater	Cumulative Wet
Gowganda	Cumulative Wet & Dry
Winisk	Cumulative Wet
Whitman Creek	Event Wet

MERLIN

Site Evaluation

Advantages:

- representative of topography and ground cover
- no on-site obstructions
- representative of area
- good access year round
- no major industrial sources

Disadvantages:

- incomplete windbreak
- adjacent to a barn

Instrument Evaluation

Sangamo Type A

- low resistance on sensor
- instrument in good working order

Storage Gauge

- orifice slightly out of round
- slightly off level
- well supported

Corrective Action Required

none

PORT STANLEY

Site Evaluation

Advantages:

- representative of topography and ground cover
- no on-site obstructions
- representative of area
- good access year round
- no urban influences

Disadvantages:

- incomplete windbreak
- proximity to treatment plant

Instrument Evaluation

Primary MIC Type A

- low resistnace on sensor
- good working order otherwise

Secondary MIC Type A

- low resistance on sensor
- hood movement not smooth
- good working order otherwise

Primary Storage Gauge

- well supported
- level
- gauge orifice out of round

Secondary Storage Gauge

- well supported
- level
- gauge orifice out of round

Primary Low Volume

- 1 guy wire on tower broken
- good working order
- good shelter
- well supported

Secondary Low Volume

- good working order
- good shelter
- well supported

Operator Evaluation

Operator: John Apfelbeck

- uses only 1 pair of gloves to install and remove bags
- operator requires upgrading on sample handling techniques
- good attitude, very conscientious

Corrective Action Required

- retrain operator

PICKLE LAKE

Site Evaluation

Advantages:

- representative of ground cover and topography
- representative of area
- co-located at Climat and CAPMoN sites
- no local or area sources
- no agricultural or large urban influences
- minimal vehicular influences

Disadvantages:

- on site obstructions - trees 20m E/SE
  - tower 21m NE
- no windbreak to the west towards the lake

Instrument Evaluation

MIC

- one grid blackened
- clutch adjustment too strong
- overall performance good

Storage Gauge

- well supported on wooded stand
- level

Low Volume

- good working order
- supported on a good stand and in a wooden enclosure

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Operator Evaluation

Temporary Operator: Ron Marsil

- follows outlined sample handling procedures
- checks sampler daily

Corrective Action Required

- remove trees
- perform minor maintenance on MIC
- train new operator

FORBES TOWNSHIP

Site Evaluation

Advantages:

- representative of topography and ground cover
- no on-site obstructions
- well removed from urban and agricultural influences
- good access year round
- representative of local area
- complete windbreak

Disadvantages:

- proximity to power plant

Instrument Evaluation

Aerochem

Primary

- good working condition
- dry bucket in place, possible source of contamination

Secondary

- good working condition
- dry bucket in place, possible source of contamination

Standard Rain Gauge

Primary & Secondary - gauges level, clean and no cracks in graduate

Operator Evaluation

Operator: Mary Ingles

- follows all sample handling procedures outlined in APIOS Technical and Operating Manual
- excellent attitude
- very conscientious in sample handling

Corrective Action

- remove dry buckets from Aerochems

QUETICO CENTER

Site Evaluation

Advantages:

- no on-site obstructions
- good ground cover
- reliable power source
- easily accessible
- windbreak complete except to S-SE
- representative topography and ground cover
- site representative of area

Disadvantages:

- proximity to road

Instrument Evaluation

MIC - Sangamo

- one sensor blackened, hot to touch
- instrument supported well and on a good stand
- sampler activated with 200 Ω resistance
- sampler generally in good working order except for blackened sensor grid and low resistance on sensor

Aerochem

- sampler in good working order
- water dripping from sensor head
- dry bucket in place, possible source of contamination
- poor seal on bucket
- new motor and sensor installed

Standard Rain Gauge

- gauge level, clean and no cracks in graduate

Operator Evaluation

Operator: Austin Donohue

- operator leans over sample bag when changing bag
- air not forced out of bag before sealing
- gloves not worn to clean gasket, hand touches gasket
- same gloves used to handle outside of bucket and install new bag
- the instrument body and component parts should be cleaned more often
- operator has a good attitude and would be an excellent operator if retrained

Corrective Action Required

- sensor grids on MIC to be changed
- dry bucket should be removed from Aerochem
- Aerochem should be adjusted to provide a good seal on wet bucket
- operator to be retained and periodically checked to ensure that he is following proper sample handling procedures

EAR FALLS

Site Evaluation

Advantages:

- representative of topography
- good accessibility and security

Disadvantages:

- poor ground cover - gravel
- on-site obstructions 2 trees 10 m NE (~ 8 m tall)
- gasoline tank 8 m NE
- proximity to parking lot or roads
- adjacent to storage area and construction (garage)
- ground slopes E-SE
- light industry 3 km W

Instrument Evaluation

MIC

- limit switch needs to be replaced and set properly
- chain needs to be tightened
- no other problems with instrument
- supported well and level

Storage Gauge

- supported on a wooden stand
- level

Low Volume

- not operating at time of audit
- well supported inside a housing unit

Operator Evaluation

Operator: Harold Atkinson

- operator not present at time of audit

Corrective Action Required

- site has many deviations, some of which can be ameliorated (e.g. cut trees, plant grass, clean-up area, etc.)
- deviations which cannot be improved include proximity to open ore pit mine, vehicular influence, light industries and poor ground slope
- relocate site, if not possible, then historical data should be reviewed to determine if valid samples are being collected. Site should be removed from the APIOS network if data indicates that invalid samples are being collected
- perform maintenance on MIC e.g. replace limit switch, tighten chain
- operator should check instruments frequently (twice per week) while construction is on-going
- low vol down for minimum of 5 days prior to audit; instrument had been unplug by contractor

EXPERIMENTAL LAKES AREA (E.L.A.)

Site Evaluation

Advantages:

- representative of topography and ground cover
  ground cover: moss, rock and blueberry plants
- well removed from urban and agricultural infuences (remote site)
- representative of local area
- located at a research facility
- very little vehicular traffic in the area

Disadvantages:

- on-site obstruction, tower 14 m NE
- incomplete windbreak - forest fire destroyed trees in surrounding area

Instrument Evaluation

MIC

- clutch adjustment too strong > 30 lbs
- motor humming when not operating
- overall performance very good
- supported properly and level

Storage Gauge

- well supported on wooden stand
- level

Operator Evaluation

Operator: Ken Beatty

- operator feels sample handling area too cramped resulting in poor sample handling technique
- operator would like more information on APIOS as well as complete Technical and Operating Manual
- conscientious - checks sampler daily
- follows sample handling procedures

Corrective Action Required

- move sampler away from tower
- perform minor maintenance on MIC - loosen clutch pad
- technologist to forward complete APIOS Technical and Operating Manual to operator

DORSET

Site Evaluation

Advantages:

- located at government research facility
- representative of topography and ground cover
- operated by APIOS regional technologist
- good accessibility
- co-located at CAPMoN, CLIMAT sites
- no on-site obstructions
- no industrial or urban influences

Disadvantages:

- proximity to gravel & sand road parking lot, however, a bank of trees separates the road from the sampler

Instrument Evaluation

Primary Sangamo

- clutch adjustment too strong > 35 lbs
- instrument in good working order
- well maintained

Secondary Sangamo

- clutch adjustment too strong > 35 lbs
- limit switch requires adjustment - screw not making proper contact with switch
- motor runs or after instrument is turned off
- "C" clamp needs adjustment
- on/off switch not working properly
- hood drops suddenly
- good seal on knife edge

Primary Low Vol
- stand well supported and level
- sample line weathering - should be changed
- low vol in good housing
- operating properly
- slightly off calibration

Secondary Low Vol
- stand well supported and level
- low vol in good housing
- operating properly

Primary Storage Gauge
- orifice out of round
- well supported on stand
- not level
- "U" bolt not tight

Secondary Storage Gauge
- orifice out of round
- well supported on stand
- not level
- "U" bolt not tight

Operator Evaluation

Operator: Cumulative Network - J.P. Varto
Event Network - G. Carlyle

Cumulative
- regional technologist
- very good attitude
- secondary MIC requires maintenance
- event operator needs refresher on sample handling

- very little chance of sample contamination when sample changed

Corrective Action Required

- event operator requires retraining
  - secondary MIC should be serviced
  - consideration should be given to paving parking lot and access road

WHITNEY

Site Evaluation

Advantages:

- representative of topography
- remote
- no agricultural or urban influences
- no vehicular activity in area
- no on-site obstruction
- accessible year round
- acceptable windbreak

Disadvantages:

- proximity to sawmill
- proximity to swamp
- exposed earth

Instrument Evaluation

MIC

- clutch adjustment too strong
- limit switch needs to be adjusted - too much pressure on bracket
- overall performance good

Storage Gauge

- well supported on wooden stand
- level
- mesh screen installed to keep birds out

Operator Evaluation

Operator: Rick Hawkins

- operator not present at time of audit

Corrective Action Required

- seed or sod to cover exposed earth
- perform regular maintenance on MIC

COLDWATER

Site Evaluation

Advantages:

- representative of topography and ground cover
- no vehicular influences
- complete windbreak
- no on-site obstructions
- accessible year round

Disadvantages:

- open pit limestone quarry 10 km E (blasting 2-3 times per week)

Instrument Evaluation

Sangamo Type A

- very good working order, no problems

Storage Gauge

- well supported on wooden stand
- gauge orifice out of round

Operator Evaluation

Operator: Ron or Sharon Hancock

- operator does not follow sampling protocol
- folds over bag before it is tied
- does not force air out of bag before sealing
- does not always wear gloves when changing samples during winter months

- sample bags not labelled
- does not wear gloves to clean gasket
- touches inside of bag with ungloved hands
- operators have an excellent attitude and are very enthusiastic

Corrective Action Required

- operators should be retrained and then checked on periodically (every six months)
- historical data should be reviewed to see if the limestone quarry affects the integrity of the samples collected

GOWGANDA

Site Evaluation

Advantages:

- well removed from any major sources of pollution
- well removed from any agricultural or urban influences
- representative of local topography and ground cover
- representative of area
- no ground slope

Disadvantages:

- poor access during winter months
- tower (20 m SE) on-site obstruction
- poor windbreak

MIC

- clutch set too strong > 35 lbs
- overall performance, good
- sample bucket slightly out of round

Storage Gauge

- supported by a wooden stand
- contained transmission oil and water
- level

Low Volume Sampler

- flow calibration not performed due to problems with the mass flow meter
- overall performance of low vol, good
- located in good shelter well supported

Operator Evaluation

Operator: Bonnie Trajkowicz

- follows sample handling procedures outlined in APIOS Technical and Operating Manual
- operator feels she was not adequately trained
- over 1 year since procedures reviewed with operator
- operator should be retrained - even though she is following the outlined procedures, she is not confident about the quality of the samples she collects
- operator has an excellent attitude demonstrated by her concern for her sample handling technique

Corrective Action Required

- retrain operator
- minor maintenance should be performed on MIC

WINISK

Site Evaluation

Advantages:

- representative of topography and ground cover
- remote
- representative of area
- good access year round
- no on-site obstructions

Disadvantages:

- snowmobile road adjacent to sampler
- sampler located at airport - possible contamination from airplane exhaust and human activity
- diesel generator 24 hrs/day

Instrument Evaluation

Sangamo Type A

- not operational when auditor arrived
- sensor grid broken
- clutch set too strong > 35 lbs
- possibly not functioning for months

Storage Gauge

- storage gauge empty at time of audit
- no storage gauge results reported during months preceeding audit

Operator Evaluation

Operator: Joe Bird

- does not change samples at proper time
- not careful with knife edge so as not to contaminate it
- sample bags never labelled
- operator performs no instrument checks, cleaning or maintenance
- does not wear new gloves to pat down bag during installation
- operator claims he wa never trained
- operator claims he is not being paid and therefore has little interest
- operator has a very poor attitude
- submission sheets not filled out properly
- recommend a new operator be found and properly trained since it is doubtful that present operator can be retrained to operate the site properly

Corrective Action Required

- move site away from snowmobile road or have snowmobilers use a different route
- replace operator or remove site

WHITMAN CREEK

Site Evaluation

Advantages:

- representative of topography and ground cover
- good access year round
- well removed from pollution sources and urban influences
- no on-site obstructions
- representative of local area

Disadvantages:

- unreliable power source, numerous events missed during winter months
- proximity to road

Instrument Evaluation

Aerochem

- sensor sensitivity requires slight adjustment, sampler does not open for short duration (<5 minutes) events
- instrument in good working order
- better bag fit due to holes in sample bucket

Standard Rain Gauge

- gauge level and has no cracks in it
- graduate requires cleaning

Operator Evaluation

Operator: Sophie Angement

- follows all sample handling procedures outlined in APIOS Technical and Operating Manual
- excellent attitude and always informs technician of problems

Corrective Action Required

- if a reliable power service cannot be obtained at this location the site should be moved to a location where reliable power is available, too many events missed

APPENDIX III

"REPORTING LOW LEVEL DATA" BULLETIN

FROM THE QUALITY CONTROL HANDBOOK FOR
PILOT WATERSHED STUDIES, PLUARG, IJC

Revised March 13, 1980
J. L. Clark

REPORTING LOW LEVEL DATA

There are specific problems in the reporting of low level data which are associated with the question: is a substance present? While this question is seldom germane in IJC work concerned with loading estimation, it has so influenced thinking about reporting low level data that it seems best to consider it in some depth before dealing with how such data are to be reported for IJC purposes.

In answering the question "is a substance present?" there are two possible correct conclusions which may be reached. One may conclude that the substance is present when it is present, and one may conclude that the substance is not present* when it is not present. Conversely, there are two possible erroneous conclusions which may be reached. One may conclude that the substance is present when it is not, and one may conclude that the substance is not present when it is. The first kind of error, finding something which is not there, is called a TYPE I ERROR. The second kind of error, not finding something which is there, is called a TYPE II ERROR.

These two types of errors are illustrated in the material that follows, using the result which might be obtained from a single analysis when the substance is not present to illustrate Type I error and the inferences that might be drawn from a single analysis at two different actual concentrations to illustrate Type II error.

Of course inferences as to water quality are seldom, if ever, based on the result of a single analysis. A single result is used here to simplify the exposition.

*Since Avogadro's number is very large, a pedant could argue that one should never claim that a substance is not present. A common sense meaning of not present is intended here, i.e. if measurement is being made in micrograms per litre the presence of a few nanograms per litre is irrelevant.

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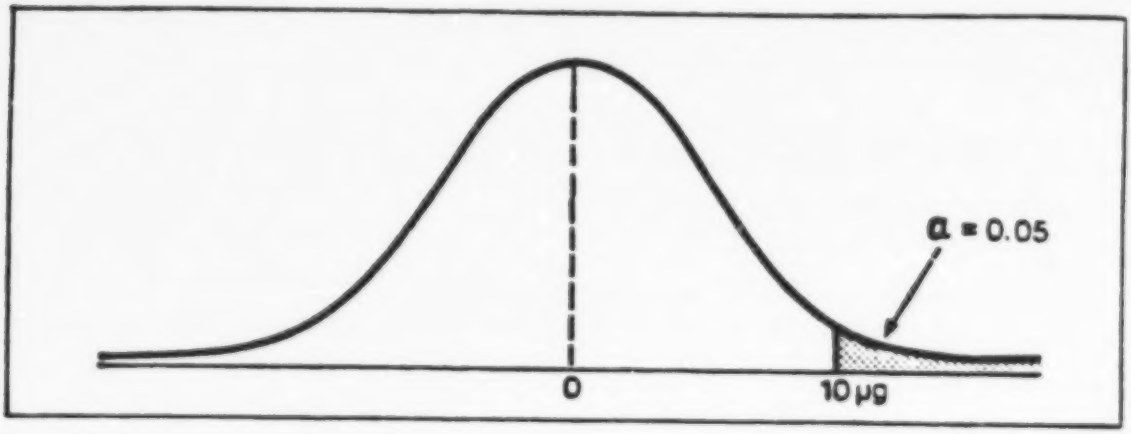
If the standard deviation, σ, of an analytical procedure has been determined at low concentrations including 0, then the probability of making a Type I error can be set by choosing an appropriate α level to determine the Criterion of Detection.†

For example, suppose that the standard deviation, σ, of an analytical procedure is 6 µg/litre and that an α of 0.05 is deemed acceptable so that the probability of making a Type I error is set at 5%. The Criterion of Detection can then be found from a table of cumulative normal probabilities to be 1.645 σ = 1.645 x 6 µg/litre = 10 µg/litre.



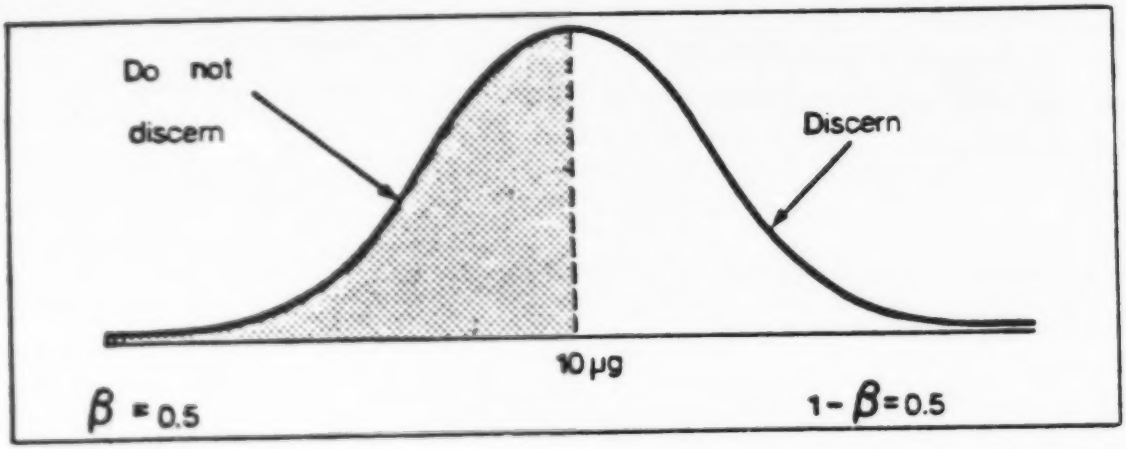
Any value observed below 10 µg/litre would be reported as less than the Criterion of Detection, since to report such a value otherwise would increase the probability of making a Type I error beyond 5%.

Note that the context of decision is the analytical result produced by the laboratory. A result is obtained and a response made to it. Nothing has been said concerning the ability to detect a substance which is present at a specified concentration.

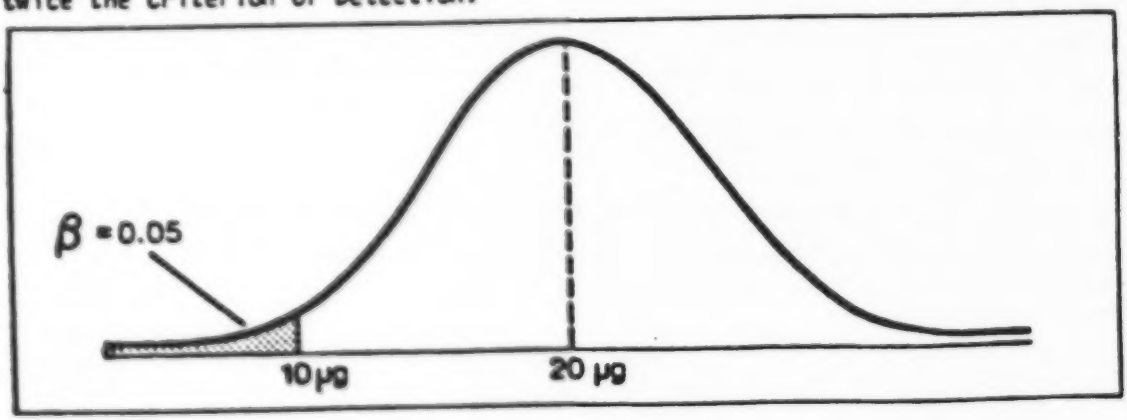
†Criterion of Detection may be a new term to some. It refers to the minimum analytical result which must be observed before it can be stated that a substance has been discerned with an acceptable probability that the statement is true. The terms Detection Limit or Limit of Detection are often used with this meaning, but in this Handbook they are reserved for a more appropriate usage.

Once the Criterion of Detection has been set, the probability of making a Type II error, β, or its complement $1-\beta$, the probability of discerning the substance when it is present, can be determined for <u>given</u> <u>true</u> <u>situations</u>. (The probability $1-\beta$ is sometimes called the power of the test).

Consider the same analytical procedure as above with a Criterion of Detection of 10 µg/litre. Suppose that the concentration of the sample being analyzed is 10 µg/litre, i.e. the concentration is equal to the Criterion of Detection. If, all analytical results below the Criterion of Detection were reported as such, then the probability of discerning the substance would be 0.5 or 50%.



Conversely, the probability of making a Type II error and failing to discern the substance would also be 0.5. From this example it can be seen that the probability of discerning a substance when its concentration is equal to the Criterion of Detection is hardly overwhelming. In order for the probability of a Type II error to be equal to the probability of a Type I error, $\beta = \alpha$, then the concentration of the sample being analyzed must be twice the Criterion of Detection.



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This concentration of twice the Criterion of Detection is the Limit of Detection when it has been decided that the risk of making a Type II error is to be equal to the risk of making a Type I error.

The concept of Type II error has been emphasized because it is usually ignored. Generally, attention is paid to the avoidance of Type I error with no consideration given to the probability of making a Type II error. It should also be recognized that when the probability of making a Type I error is decreased by selecting a lower α-level, the probability of making a Type II error is increased.

Having, it is hoped, made clear the conceptual context in which an α-level is set and the difference between the Criterion of Detection and the Limit of Detection, IJC requirements in the reporting of low level data can be considered.

> *In general, only under highly exceptional circumstances need there be a concern with avoiding Type I error when reporting data for IJC purposes.*

There are two reasons why Type I error is not a concern. First, the IJC is not an enforcement agency, and therefore is not concerned that a single datum will lead it into a false accusation that a substance is present when it is not. Second, in virtually all cases data are aggregated for IJC purposes in order to provide estimates of loadings and/or concentrations; therefore the avoidance of Type I error relates to data sets and not to the individual datum.

This second point is crucial. Rarely, if ever, will the analytical chemist have responsibility for inference from data sets or even be in a position to know which data may be combined. Therefore, censoring of results to prevent a possible faulty inference being drawn from an individual datum represents an unwarrented assumption of responsibility.

In practice, these considerations mean that the Criterion of Detection may be set as low as possible. To state it another way, the α-level may be ignored.

On the other hand, when reporting data for IJC purposes every effort must be made to avoid Type II error.

The reason is obvious. When results are reported as "less than" or "below the Criterion of Detection," they are virtually useless for either estimating loadings or concentrations.

In practice, this consideration means that if a number can be obtained, it is to be reported.

CODES TO BE USED IN REPORTING LOW LEVEL DATA

At its April 12, 1976 meeting the Data Quality Subcommittee of the Water Quality Board passed a resolution that 2 new codes be made available in data storage systems for remarks concerning data used in IJC reports. The codes are T and W.

The T code has the following meaning: "Value reported is less than Criterion of Detection." The use of this code warns the data user that the individual datum with which it is associated does not, in the judgement of the laboratory which did the analysis, differ significantly from 0.

It should be recognized than an implied significance test which fails to reject the null hypothesis that a result does not differ from a standard value in no way diminishes the value of the result as an estimate. To illustrate: a result of 9 µg on a test whose $\sigma = 6$ µg can not be regarded as significantly different from 0 for any α-level less than 0.067; however, if a significance test were made with $\alpha = 0.1$, then the null hypothesis would be rejected and the result deemed significantly different from 0.

So the result, 9 µg, could be reported as "Below the Criterion of Detection" for all α less than 0.067 and could be reported as simply "9 µg" for all α greater than 0.067. But however reported, the result of 9 µg remains the best estimate of the true value since changing the risk of making a Type I error neither augments or diminishes the value of an estimate.

It may be added that low level results are better estimates, in the sense of being more precise, than higher results since for all analytical tests with which we are acquainted the standard deviation of the test increases with the concentration.

The W code has the following meaning: "Value observed is less than lowest value reportable under T code." This code is used when a positive value is not observed or calculated for a result. In these cases the lowest reportable value, which is the lowest positive value which is observable, is reported with the W.

The following example illustrates the use of the codes:

Suppose that a laboratory has determined that its Criterion of Detection for total phosphorus is 10 µg/litre, and suppose in addition that the smallest increment that can be read on the analytical device corresponds to a concentration of 2 µg/litre. Given these conditions, any value observed ≥10 µg/litre would be reported without an accompanying code; any value observed ≥2 µg and <10 µg would be reported with the T code; if no instrument response were observed, the result would be reported as 2W.

REPORTING NEGATIVE RESULTS

With many analytical procedures there will always be an instrument response, so the W code will not apply. In particular, this lack of applicability will occur when a result is obtained through subtraction of a blank correction. In this case negative results will often be obtained; in fact, if the constituent of interest is not present, one would expect negative results to occur as often as positive.

In order that valid inferences may be made from surveillance data, it is important that negative results be reported as such. Consider the following three different ways of reporting the same results. The left hand column gives results in a heavily censored form; the center column has negative results censored; the right hand column gives the results as obtained.

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<3 µg	2 µg	2 µg
<3	0	-2
<3	0	-1
4	4	4
3	3	3
<3	0	-3
<3	1	1
<3	0	-1
<3	0	0
<3	2	2

Nothing can be done with the results in the left hand column except to conclude that we don't know whether the constituent is present or not; the sampling and analytical effort have been wasted.

If the results in the center column were taken at face value, one could conclude that the mean concentration was 1.2 µg with a standard error of the mean of 0.467 and 95% confidence limits for the mean of 0.14 µg and 2.26 µg. Since the confidence limits do not include zero, it would appear that the evidence supports the presence of the constituent.

Analysis of the uncensored results of the right hand column gives a mean concentration of 0.5 ug, a standard error of the mean of 0.719, and 95% confidence limits for the mean of -1.13 µg and 2.13 µg. The correct conclusion can be drawn that the evidence is insufficient to support the presence of the constituent.

Note that the censored data of the center column distort both the mean and the standard error of the data, making the data appear more precise than they are.

Of course any result of 0 or less which is reported should be reported with the T code.